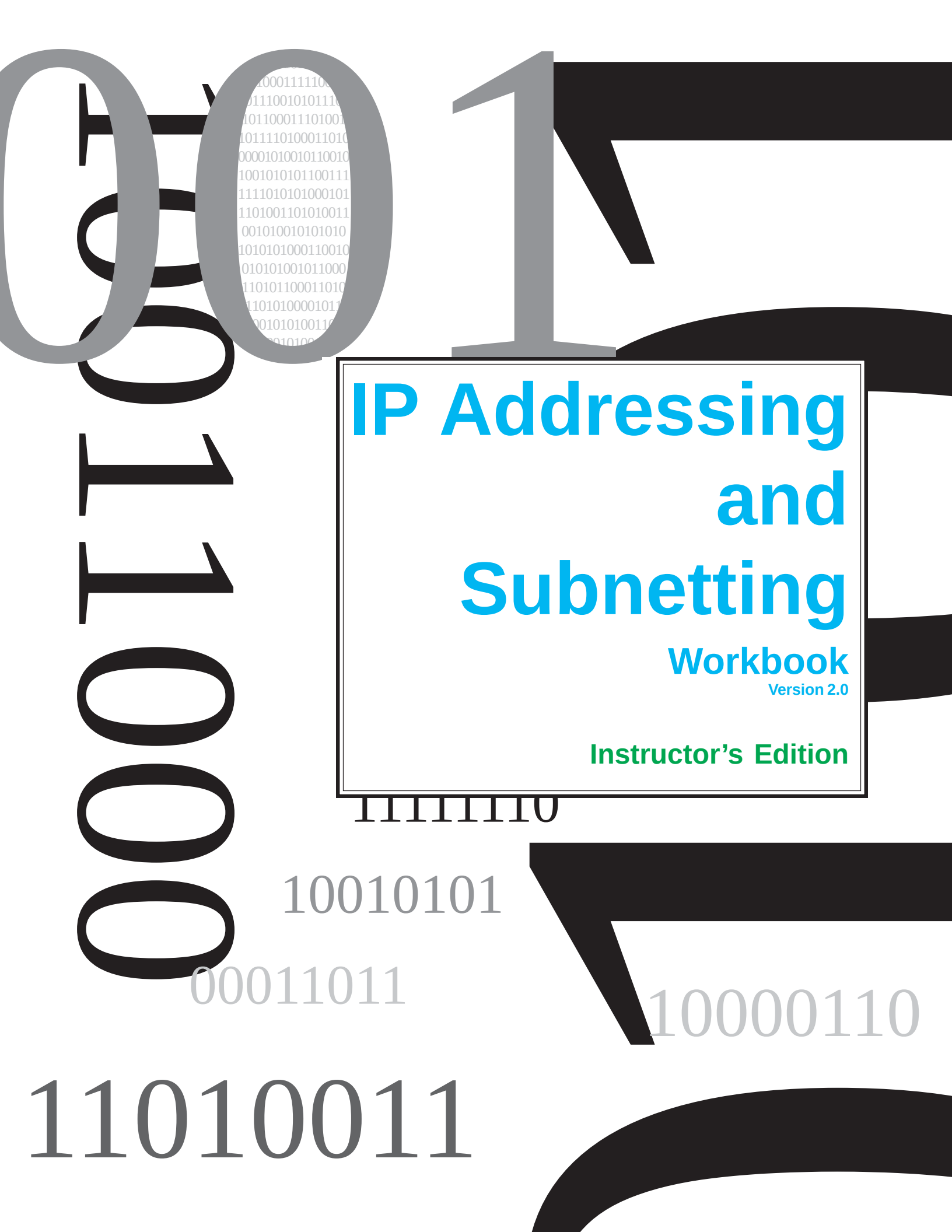




The background features large, stylized binary digits (0s and 1s) in black and gray. A white rectangular box with a thin black border is positioned in the center-right, containing the title and edition information. The title 'IP Addressing and Subnetting' is written in a large, bold, blue sans-serif font. Below it, 'Workbook' is in a smaller blue font, and 'Version 2.0' is in an even smaller blue font. At the bottom of the box, 'Instructor's Edition' is written in a green font. The overall design is clean and technical, emphasizing the binary nature of IP addressing.

IP Addressing and Subnetting

Workbook
Version 2.0

Instructor's Edition

IP Address Classes

Class A	1 – 127	(Network 127 is reserved for loopback and internal testing)	
	Leading bit pattern	0	00000000.00000000.00000000.00000000 Network . Host . Host . Host
Class B	128 – 191	Leading bit pattern	10
			10000000.00000000.00000000.00000000 Network . Network . Host . Host
Class C	192 – 223	Leading bit pattern	110
			11000000.00000000.00000000.00000000 Network . Network . Network . Host
Class D	224 – 239	(Reserved for multicast)	
Class E	240 – 255	(Reserved for experimental, used for research)	

Private Address Space

Class A	10.0.0.0 to 10.255.255.255
Class B	172.16.0.0 to 172.31.255.255
Class C	192.168.0.0 to 192.168.255.255

Default Subnet Masks

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

Produced by: Robb Jones

Special Thanks to Melvin Baker and Jim Dorsch
for taking the time to check this workbook for errors,
and to everyone who has sent in suggestions to improve the series.

Workbooks included in the series:

IP Addressing and Subnetting Workbooks
ACLs - Access Lists Workbooks
VLSM Variable-Length Subnet Mask Workbooks

Instructors (and anyone else for that matter) please do not post the Instructors version on public websites. When you do this you are giving everyone else worldwide the answers. Yes, students look for answers this way. It also discourages others; myself included, from posting high quality materials.

Inside Cover

Binary To Decimal Conversion

128	64	32	16	8	4	2	1	Answers	Scratch Area
1	0	0	1	0	0	1	0	<u>146</u>	128 16 32
0	1	1	1	0	1	1	1	<u>119</u>	2 16 4
1	1	1	1	1	1	1	1	<u>255</u>	2 1
1	1	0	0	0	1	0	1	<u>197</u>	119
1	1	1	1	0	1	1	0	<u>246</u>	
0	0	0	1	0	0	1	1	<u>19</u>	
1	0	0	0	0	0	0	1	<u>129</u>	
0	0	1	1	0	0	0	1	<u>49</u>	
0	1	1	1	1	0	0	0	<u>120</u>	
1	1	1	1	0	0	0	0	<u>240</u>	
0	0	1	1	1	0	1	1	<u>59</u>	
0	0	0	0	0	1	1	1	<u>7</u>	
							00011011	<u>27</u>	
							10101010	<u>170</u>	
							01101111	<u>111</u>	
							11111000	<u>248</u>	
							00100000	<u>32</u>	
							01010101	<u>85</u>	
							00111110	<u>62</u>	
							00000011	<u>3</u>	
							11101101	<u>237</u>	
							11000000	<u>192</u>	

Decimal To Binary Conversion

Use all 8 bits for each problem

128	64	32	16	8	4	2	1 = 255	Scratch Area	
1	1	1	0	1	1	1	0	238	238
0	0	1	0	0	0	1	0	34	-128
0	1	1	1	1	0	1	1	123	110
0	0	1	1	0	0	1	0	50	-64
1	1	1	1	1	1	1	1	255	46
1	1	0	0	1	0	0	0	200	-32
0	0	0	0	1	0	1	0	10	14
1	0	0	0	1	0	1	0	138	-8
0	0	0	0	0	0	0	1	1	6
0	0	0	0	1	1	0	1	13	-4
1	1	1	1	1	0	1	0	250	2
0	1	1	0	1	0	1	1	107	-2
1	1	1	0	0	0	0	0	224	0
0	1	1	1	0	0	1	0	114	
1	1	0	0	0	0	0	0	192	
1	0	1	0	1	1	0	0	172	
0	1	1	0	0	1	0	0	100	
0	1	1	1	0	1	1	1	119	
0	0	1	1	1	0	0	1	57	
0	1	1	0	0	0	1	0	98	
1	0	1	1	0	0	1	1	179	
0	0	0	0	0	0	1	0	2	

Address Class Identification

Address	Class
10.250.1.1	<u>A</u>
150.10.15.0	<u>B</u>
192.14.2.0	<u>C</u>
148.17.9.1	<u>B</u>
193.42.1.1	<u>C</u>
126.8.156.0	<u>A</u>
220.200.23.1	<u>C</u>
230.230.45.58	<u>D</u>
177.100.18.4	<u>B</u>
119.18.45.0	<u>A</u>
249.240.80.78	<u>E</u>
199.155.77.56	<u>C</u>
117.89.56.45	<u>A</u>
215.45.45.0	<u>C</u>
199.200.15.0	<u>C</u>
95.0.21.90	<u>A</u>
33.0.0.0	<u>A</u>
158.98.80.0	<u>B</u>
219.21.56.0	<u>C</u>

Network & Host Identification

Circle the network portion
of these addresses:

177.100.18.4

119.18.45.0

209.240.80.78

199.155.77.56

117.89.56.45

215.45.45.0

192.200.15.0

95.0.21.90

33.0.0.0

158.98.80.0

217.21.56.0

10.250.1.1

150.10.15.0

192.14.2.0

148.17.9.1

193.42.1.1

126.8.156.0

220.200.23.1

Circle the host portion of
these addresses:

10.15.123.50

171.2.199.31

198.125.87.177

223.250.200.222

17.45.222.45

126.201.54.231

191.41.35.112

155.25.169.227

192.15.155.2

123.102.45.254

148.17.9.155

100.25.1.1

195.0.21.98

25.250.135.46

171.102.77.77

55.250.5.5

218.155.230.14

10.250.1.1

Network Addresses

Using the IP address and subnet mask shown write out the network address:

188.10.18.2 255.255.0.0	<u>188 . 10 . 0 . 0</u>
10.10.48.80 255.255.255.0	<u>10 . 10 . 48 . 0</u>
192.149.24.191 255.255.255.0	<u>192 . 149 . 24 . 0</u>
150.203.23.19 255.255.0.0	<u>150 . 203 . 0 . 0</u>
10.10.10.10 255.0.0.0	<u>10 . 0 . 0 . 0</u>
186.13.23.110 255.255.255.0	<u>186 . 13 . 23 . 0</u>
223.69.230.250 255.255.0.0	<u>223 . 69 . 0 . 0</u>
200.120.135.15 255.255.255.0	<u>200 . 120 . 135 . 0</u>
27.125.200.151 255.0.0.0	<u>27 . 0 . 0 . 0</u>
199.20.150.35 255.255.255.0	<u>199 . 20 . 150 . 0</u>
191.55.165.135 255.255.255.0	<u>191 . 55 . 165 . 0</u>
28.212.250.254 255.255.0.0	<u>28 . 212 . 0 . 0</u>

Host Addresses

Using the IP address and subnet mask shown write out the host address:

188.10.18.2 255.255.0.0	<u>0 . 0 . 18 . 2</u>
10.10.48.80 255.255.255.0	<u>0 . 0 . 0 . 80</u>
222.49.49.11 255.255.255.0	<u>0 . 0 . 0 . 11</u>
128.23.230.19 255.255.0.0	<u>0 . 0 . 230 . 19</u>
10.10.10.10 255.0.0.0	<u>0 . 10 . 10 . 10</u>
200.113.123.11 255.255.255.0	<u>0 . 0 . 0 . 11</u>
223.169.23.20 255.255.0.0	<u>0 . 0 . 23 . 20</u>
203.20.35.215 255.255.255.0	<u>0 . 0 . 0 . 215</u>
117.15.2.51 255.0.0.0	<u>0 . 15 . 2 . 51</u>
199.120.15.135 255.255.255.0	<u>0 . 0 . 0 . 135</u>
191.55.165.135 255.255.255.0	<u>0 . 0 . 0 . 135</u>
48.21.25.54 255.255.0.0	<u>0 . 0 . 25 . 54</u>

Default Subnet Masks

Write the correct default subnet mask for each of the following addresses:

177.100.18.4	<u>255 . 255 . 0 . 0</u>
119.18.45.0	<u>255 . 0 . 0 . 0</u>
191.249.234.191	<u>255 . 255 . 0 . 0</u>
223.23.223.109	<u>255 . 255 . 255 . 0</u>
10.10.250.1	<u>255 . 0 . 0 . 0</u>
126.123.23.1	<u>255 . 0 . 0 . 0</u>
223.69.230.250	<u>255 . 255 . 255 . 0</u>
192.12.35.105	<u>255 . 255 . 255 . 0</u>
77.251.200.51	<u>255 . 0 . 0 . 0</u>
189.210.50.1	<u>255 . 255 . 0 . 0</u>
88.45.65.35	<u>255 . 0 . 0 . 0</u>
128.212.250.254	<u>255 . 255 . 0 . 0</u>
193.100.77.83	<u>255 . 255 . 255 . 0</u>
125.125.250.1	<u>255 . 0 . 0 . 0</u>
1.1.10.50	<u>255 . 0 . 0 . 0</u>
220.90.130.45	<u>255 . 255 . 255 . 0</u>
134.125.34.9	<u>255 . 255 . 0 . 0</u>
95.250.91.99	<u>255 . 0 . 0 . 0</u>

ANDING with Default subnet masks

Every IP address must be accompanied by a subnet mask. By now you should be able to look at an IP address and tell what class it is. Unfortunately your computer doesn't think that way. For your computer to determine the network and subnet portion of an IP address it must "AND" the IP address with the subnet mask.

Default Subnet Masks:

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

ANDING Equations:

1 AND 1	= 1
1 AND 0	= 0
0 AND 1	= 0
0 AND 0	= 0

Sample:

What you see...

IP Address: 192 . 100 . 10 . 33

What you can figure out in your head...

Address Class:	C
Network Portion:	<u>192 . 100 . 10</u> . 33
Host Portion:	192 . 100 . 10 . <u>33</u>

In order for your computer to get the same information it must AND the IP address with the subnet mask in binary.

	Network	Host	
IP Address:	1 1 0 0 0 0 0 0 . 0 1 1 0 0 1 0 0 . 0 0 0 0 1 0 1 0	0 0 1 0 0 0 0 1	(192 . 100 . 10 . 33)
Default Subnet Mask:	1 1 1 1 1 1 1 1 . 0 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0	(255 . 255 . 255 . 0)
AND:	1 1 0 0 0 0 0 0 . 0 1 1 0 0 1 0 0 . 0 0 0 0 1 0 1 0	0 0 0 0 0 0 0 0	(192 . 100 . 10 . 0)

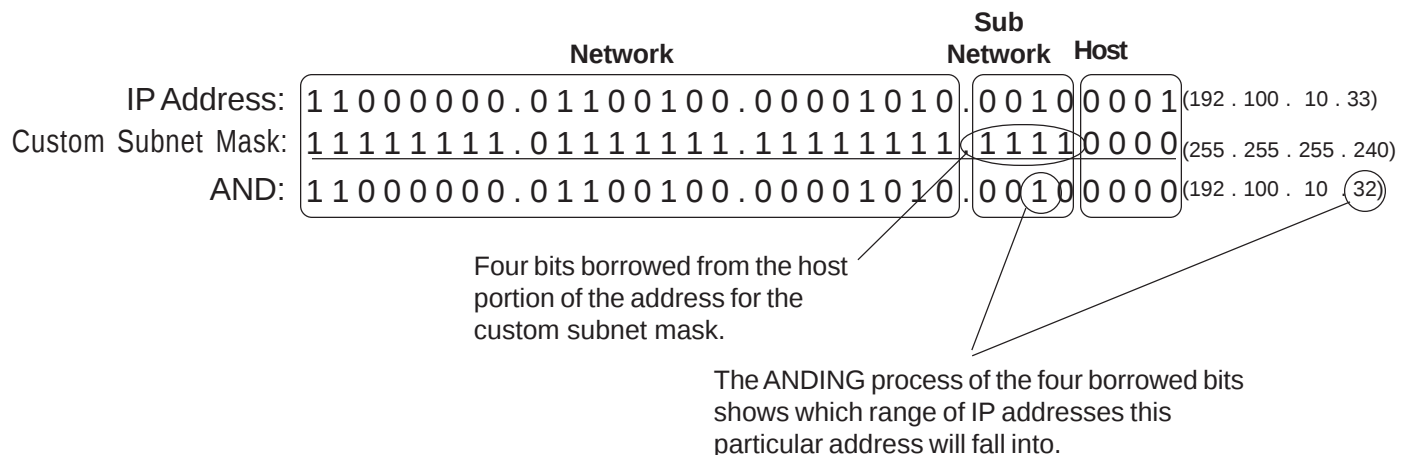
ANDING with the default subnet mask allows your computer to figure out the network portion of the address.

ANDING with Custom subnet masks

When you take a single network such as 192.100.10.0 and divide it into five smaller networks (192.100.10.16, 192.100.10.32, 192.100.10.48, 192.100.10.64, 192.100.10.80) the outside world still sees the network as 192.100.10.0, but the internal computers and routers see five smaller subnetworks. Each independent of the other. This can only be accomplished by using a custom subnet mask. A custom subnet mask borrows bits from the host portion of the address to create a subnetwork address between the network and host portions of an IP address. In this example each range has 14 usable addresses in it. The computer must still AND the IP address against the custom subnet mask to see what the network portion is and which subnetwork it belongs to.

IP Address: 192 . 100 . 10 . 0
Custom Subnet Mask: 255.255.255.240

Address Ranges: 192.10.10.0 to 192.100.10.15
 192.100.10.16 to 192.100.10.31
 192.100.10.32 to 192.100.10.47 (Range in the sample below)
 192.100.10.48 to 192.100.10.63
 192.100.10.64 to 192.100.10.79
 192.100.10.80 to 192.100.10.95
 192.100.10.96 to 192.100.10.111
 192.100.10.112 to 192.100.10.127
 192.100.10.128 to 192.100.10.143
 192.100.10.144 to 192.100.10.159
 192.100.10.160 to 192.100.10.175
 192.100.10.176 to 192.100.10.191
 192.100.10.192 to 192.100.10.207
 192.100.10.208 to 192.100.10.223
 192.100.10.224 to 192.100.10.239
 192.100.10.240 to 192.100.10.255



In the next set of problems you will determine the necessary information to determine the correct subnet mask for a variety of IP addresses.

How to determine the number of subnets and the number of hosts per subnet

Two formulas can provide this basic information:

Number of subnets = 2^s (Second subnet formula: **Number of subnets = $2^s - 2$**)

Number of hosts per subnet = $2^h - 2$

Both formulas calculate the number of hosts or subnets based on the number of binary bits used. For example if you borrow three bits from the host portion of the address use the *number of subnets* formula to determine the total number of subnets gained by borrowing the three bits. This would be 2^3 or $2 \times 2 \times 2 = 8$ subnets

To determine the number of hosts per subnet you would take the number of binary bits used in the host portion and apply this to the *number of hosts per subnet* formula. If five bits are in the host portion of the address this would be 2^5 or $2 \times 2 \times 2 \times 2 \times 2 = 32$ hosts.

When dealing with the *number of hosts per subnet* you have to subtract two addresses from the range. The first address in every range is the subnet number. The last address in every range is the broadcast address. These two addresses cannot be assigned to any device in the network which is why you have to subtract two addresses to find the number of usable addresses in each range.

For example if two bits are borrowed for the network portion of the address you can easily determine the number of subnets and hosts per subnets using the two formulas.

195. 223 . 50 . 0 0 | 0 0 0 0 0 0

The number of subnets created by borrowing 2 bits is 2^2 or $2 \times 2 = 4$ subnets.

The number of hosts created by leaving 6 bits is $2^6 - 2$ or $2 \times 2 \times 2 \times 2 \times 2 \times 2 = 64 - 2 = 62$ usable hosts per subnet.

What about that second subnet formula:

Number of subnets = $2^s - 2$

In some instances the first and last subnet range of addresses are reserved. This is similar to the first and last host addresses in each range of addresses.

The first range of addresses is the **zero subnet**. The subnet number for the *zero subnet* is also the subnet number for the classful subnet address.

The last range of addresses is the **broadcast subnet**. The broadcast address for the last subnet in the *broadcast subnet* is the same as the classful broadcast address.

Class C Address unsubnetted:

195. 223 . 50 . 0

195.223.50.0 to 195.223.50.255

Class C Address subnetted (2 bits borrowed):

195. 223 . 50 . 0 0 | 0 0 0 0 0 0

(Invalid range) (0) 195.223.50.0 to 195.223.50.63
(1) 195.223.50.64 to 195.223.50.127
(2) 195.223.50.128 to 195.223.50.191
(Invalid range) (3) 195.223.50.192 to 195.223.50.255

Notice that the subnet and broadcast addresses match.

The primary reason the the zero and broadcast subnets were not used had to do primarily with the broadcast addresses. If you send a broadcast to 195.223.255 are you sending it to all 255 addresses in the classful C address or just the 62 usable addresses in the broadcast range?

The **CCNA** and **CCENT** certification exams may have questions which will require you to determine which formula to use, and whether or not you can use the first and last subnets. Use the chart below to help decide.

When to use which formula to determine the number of subnets	
Use the $2^S - 2$ formula and don't use the zero and broadcast ranges if...	Use the 2^S formula and use the zero and broadcast ranges if...
Classful routing is used	Classless routing or VLSM is used
RIP version 1 is used	RIP version 2, EIGRP, or OSPF is used
The no ip subnet zero command is configured on your router	The ip subnet zero command is configured on your router (default setting)
	No other clues are given

Bottom line for the CCNA exams; if a question does not give you any clues as to whether or not to allow these two subnets, assume you can use them.

This workbook has you use the number of subnets = 2^S formula.

Custom Subnet Masks

Problem 1

Number of needed subnets **14**
 Number of needed usable hosts **14**
 Network Address **192.10.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 240

Total number of subnets 16

Total number of host addresses 16

Number of usable addresses 14

Number of bits borrowed 4

Show your work for Problem 1 in the space below.

	256	128	64	32	16	8	4	2	1	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	Binary values
192 . 10 . 10 . 0	0	0	0	0	0	0	0	0	0	

Add the binary value numbers to the left of the line to create the custom subnet mask.

128
64
32
+16
240

16	Observe the total number of hosts.
-2	
14	Subtract 2 for the number of usable hosts.

Custom Subnet Masks

Problem 2

Number of needed subnets **1000**

Number of needed usable hosts **60**

Network Address **165.100.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

Show your work for Problem 2 in the space below.

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets -	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536
Binary values -	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
	165	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Add the binary value numbers to the left of the line to create the custom subnet mask.

128	128
64	+64
32	192
16	
8	
4	
2	
+1	
255	

64
-2
62

Observe the total number of hosts.
Subtract 2 for the number of usable hosts.

Custom Subnet Masks

Problem 3

Network Address **148.75.0.0 /26**

/26 indicates the total number of bits used for the network and subnetwork portion of the address. All bits remaining belong to the host portion of the address.

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

Show your work for **Problem 3** in the space below.

	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Hosts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Number of Subnets	-	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768
Binary values	-	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2
		148	75	0	0	0	0	0	0	0	0	0	0	0	0	0

Add the binary value numbers to the left of the line to create the custom subnet mask.

128	128
64	+64
32	192
16	
8	
4	
2	
+1	
255	

64	Observe the total number of hosts.
-2	
62	Subtract 2 for the number of usable hosts.

1024	
-2	
1,022	Subtract 2 for the total number of subnets to get the usable number of subnets.

Custom Subnet Masks

Problem 4

Number of needed subnets **6**
 Number of needed usable hosts **30**
 Network Address **195.85.8.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

Show your work for Problem 5 in the space below.

Number of Subnets	256 128 64			32 16 8 4 2					-	Number of Hosts
	2	4	8	16	32	64	128	256		
	128	64	32	16	8	4	2	1	-	Binary values
195 . 85 . 8 .	0	0	0	0	0	0	0	0		

128	32	8
64	-2	-2
+32	30	6
224		

Custom Subnet Masks

Problem 5

Number of needed subnets **6**
 Number of needed usable hosts **30**
 Network Address **210.100.56.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

Show your work for Problem 4 in the space below.

			256	128	64	32	16	8	4	2	-	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256			
		128	64	32	16	8	4	2	1	-	Binary values	
210 . 100 . 56 .			0	0	0	0	0	0	0	0		
128												
64			8									
+32			-2	32								
<u>224</u>			<u>6</u>	<u>-2</u>	30							

Custom Subnet Masks

Problem 6

Number of needed subnets **126**
 Number of needed usable hosts **131,070**
 Network Address **118.0.0.0**

Address class A

Default subnet mask 255 . 0 . 0 . 0

Custom subnet mask 255 . 254 . 0 . 0

Total number of subnets 128

Total number of host addresses 131,072

Number of usable addresses 131,070

Number of bits borrowed 7

Show your work for **Problem 6** in the space below.

Number of Hosts	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152	4194304	8388608	16777216	33554432	67108864	134217728	268435456	536870912	1073741824	2147483648	4294967296	8589934592	17179869184	34359738368	68719476736	137438953472	274877906944	549755813888	1099511627776	2199023255552	4398046511104	8796093022208	17592186044416	35184372088832	70368744177664	140737488355328	281474976710656	562949953421312	1125899906842624	2251799813685248	4503599627370496	9007199254740992	18014398509481984	36028797018963968	72057594037927936	144115188075855872	288230376151711744	576460752303423488	1152921504606846976	2305843009213693952	4611686018427387904	9223372036854775808	18446744073709551616	36893488147419103232	73786976294838206464	147573952589676412928	295147905179352825856	590295810358705651712	1180591620717411303424	2361183241434822606848	4722366482869645213696	9444732965739290427392	18889465931478580854784	37778931862957161709568	75557863725914323419136	151115727451828646838272	302231454903657293676544	604462909807314587353088	1208925819614629174706176	2417851639229258349412352	4835703278458516698824704	9671406556917033397649408	19342813113834066795298816	38685626227668133590597632	77371252455336267181195264	154742504910672534362390528	309485009821345068724781056	618970019642690137449562112	1237940039285380274899124224	2475880078570760549798248448	4951760157141521099596496896	9903520314283042199192993792	19807040628566084398385987584	39614081257132168796771975168	79228162514264337593543950336	158456325028528675187087900672	316912650057057350374175801344	633825300114114700748351602688	1267650600228229401496703205376	2535301200456458802993406410752	5070602400912917605986812821504	10141204801825835211973625643008	20282409603651670423947251286016	40564819207303340847894502572032	81129638414606681695789005144064	162259276829213363391578010288128	324518553658426726783156020576256	649037107316853453566312041152512	1298074214633706907132624082305024	2596148429267413814265248164610048	5192296858534827628530496329220096	10384593717069655257060992658440192	20769187434139310514121985316880384	41538374868278621028243970633760768	83076749736557242056487941267521536	166153499473114484112975882535043072	332306998946228968225951765070086144	664613997892457936451903530140172288	1329227995784915872903807060280344576	2658455991569831745807614120560689152	5316911983139663491615228241121378304	10633823966279326983230456482242756608	21267647932558653966460912964485513216	42535295865117307932921825928971026432	85070591730234615865843651857942052864	170141183460469231731687303715884105728	340282366920938463463374607431768211456	680564733841876926926749214863536422912	1361129467683753853853498429727072845824	272225893536750770770699685945414569152	544451787073501541541399371890829138304	1088903574147003083082798743781658276608	2177807148294006166165597487563316553216	4355614296588012332331194975126633106432	8711228593176024664662389950253266212864	17422457186352049329324779900506532425728	34844914372704098658649559801013064851456	69689828745408197317299119602026129702912	139379657490816394634598239204052259405824	278759314981632789269196478408104518811648	557518629963265578538392956816209037623296	1115037259926531157076785913632418075246592	2230074519853062314153571827264836150493184	4460149039706124628307143654529672300986368	8920298079412249256614287309059344601972736	17840596158824498513228574618118689203945472	35681192317648997026457149236237378407890848	71362384635297994052914298472474756815781696	142724769270595988105828596944949513631563392	285449538541191976211657193889899027263126784	570899077082383952423314387779798054526253568	1141798154164767904846628775559596109052507136	2283596308329535809693257551119192218105014272	4567192616659071619386515102238384436210028544	9134385233318143238773030204476768872420057088	18268770466636286477546060408953537744840114176	36537540933272572955092120817907075489680228352	73075081866545145910184241635814150979360456704	146150163733090291820368483271628301958720913408	292300327466180583640736966543256603917441826816	584600654932361167281473933086513207834883653632	1169201309864722334562947866173026415669767307264	2338402619729444669125895732346052831339534614528	4676805239458889338251791464692105662679069229056	9353610478917778676503582929384211325358138458112	18707220957835557353007165858768422650716276916224	37414441915671114706014331717536845301432553832448	74828883831342229412028663435073690602865107664896	149657767662684458824057326870147381205730215329792	299315535325368917648114653740294762411460430659584	598631070650737835296229307480589524822920861319168	1197262141301475670592458614961179049645841722638336	2394524282602951341184917229922358099291683445276672	4789048565205902682369834459844716198583366890553344	9578097130411805364739668919689432397166733781106688	19156194260823610729479337839378864794333467562213376	38312388521647221458958675678757729588666935124426752	76624777043294442917917351357515459177333870248853504	153249554086588885835834702715030918354667740497707008	306499108173177771671669405430061836709335480995414016	612998216346355543343338810860123673418670961990828224	122599643269271108668667762172024734683734192398164544	245199286538542217337335524344049469367468384796329088	490398573077084434674671048688098938734936769592658176	980797146154168869349342097376197877469873539185316352	1961594292308337738698684194752395754939747078370632704	3923188584616675477397368389504791509879494156741265408	7846377169233350954794736779009583019758988313482530816	15692754338466701909589473558019166039517976266965061328	31385508676933403819178947116038332079035952533930122656	62771017353866807638357894232076664158071905067860245312	125542034707733615276715788464153328316143810135720490624	251084069415467230553431576928306656632287620271440981248	5021681388309344611068631538566133132645752405428819648	10043362776618689222137263077132266265291504810857639296	20086725553237378444274526154264532530583009621715278592	40173451106474756888549052308529065061166019243430557184	80346902212949513777098104617058130122332038486861114368	160693804425899027554196209234116260244664076973722228736	321387608851798055108392418468232520489328153947444457728	642775217703596110216784836936465040978656307894888915456	1285550435407192220433569673872930081957312615789777830912	2571100870814384440867139347745860163914625231579555661824	5142201741628768881734278695491720327829250463159111323648	1028440348325753776346855739098344065565850092638222264736	2056880696651507552693711478196688131131700185276444529472	4113761393303015105387422956393376262263400370552889058944	8227522786606030210774845912786752524526800741105778117888	16455045573212060421549691825573505049053601482211556235776	32910091146424120843099383651147010098107202964423112471552	65820182292848241686198767302294020196214405928846224943104	131640364585696483372397534604588040392428811857692449806208	263280729171392966744795069209176080784857623715384899612416	526561458342785933489590138418352161569715247430769799224832	1053122916685571866979180276836704323139430494861539598449664	2106245833371143733958360553673408646278860989723079196899328	4212491666742287467916721107346817292557721979446158393798656	8424983333484574935833442214693634585115443958892316787597312	16849966666969149871666884429387269170230887917784633575194624	33699933333938299743333768858774538340461775835569267150389248	67399866667876599486667537717549076680923551671138534300778496	134799733335753198973335075435098153361847103342277068601556992	269599466671506397946670150870196306723694206684554137203113984	539198933343012795893340301740392613447388413369108274406227968	1078397866686025591786680603480785226894776826738216548812455936	2156795733372051183573361206961570453789553653476433097624911872	4313591466744102367146722413923140907579107306952866195249823744	8627182933488204734293444827846281815158214613905732390499647488	17254365866976409468586889655692563630316429227811464780999294976	34508731733952818937173779311385127260632858455622929571998589952	69017463467905637874347558622770254521265716911245859143997179904	138034926935811275748695117245540509042531433822491718287994359808	276069853871622551497390234491081018085062867644983436575988719616	552139707743245102994780468982162036170125735289966873151977439232	1104279415486490205989560937964324072340251470579933746303954878464	2208558830972980411979121875928648144680502941159867492607909756928	4417117661945960823958243751857296289361005882319734985215819513856	8834235323891921647916487503714592578722011764639469970431639027712	17668470647783843295832975007429185157444023529278939940863278055424	35336941295567686591665950014858370314888047058557879881726556110848	70673882591135373183331900029716740629776094117115759763453112221696	141347765182270746366663800059433481259552188234231519526906224443392	282695530364541492733327600118866962519104376468463039053812448886784	565391060729082985466655200237733925038208752936926078107624897773568	1130782121458165970933310400475467850076417505873852156215249795547136	2261564242916331941866620800950935700152835011747704312430499591094272	4523128485832663883733241601901871400305670023495408624860999182188544	9046256971665327767466483203803742800611340046990817249721998364377088	18092513943330655534932966407607485601222680093981634499443996728754176	36185027886661311069865932815214971202445360187963268998887993457508352	72370055773322622139731865630429942404890720375926537997775986915016704	144740111546645244279463731260859884809781440751853075995551973830033408	289480223093290488558927462521719769619562881503706151991103947660066816	578960446186580977117854925043439539239125763007412303982207895320133632	1157920892373161954235709850086879078478251526014824607964415790640267264	2315841784746323908471419700173758156956503052029649215928831581280534528	4631683569492647816942839400347516313913006104059298431857663162561069056	9263367138985295633885678800695032627826012208118596863715326325122138112	18526734277970591267771357601390065255652024416237193727430652650244276224	37053468555941182535542715202780130511304048832474387454861305300488552448	74106937111882365071085430405560261022608097664948774909722610600977104896	148213874223764730142170860811120522045216195329897549819445221201954309792	296427748447529460284341721622241044090432390659795099638890442403908619584	592855496895058920568683443244482088180864781319590199277780884807817239168	1185710993790117841137366886488964176361729562639180398555561769615634478336	237142198
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Custom Subnet Masks

Problem 7

Number of needed subnets **2000**
 Number of needed usable hosts **15**
 Network Address **178.100.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 2,048

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 11

Show your work for Problem 7 in the space below.

Number of Hosts	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536
Binary values	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
178 . 100 . 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

$$\begin{array}{r}
 128 \\
 64 \\
 32 \\
 16 \\
 8 \\
 4 \\
 2 \\
 +1 \\
 \hline
 255
 \end{array}
 \qquad
 \begin{array}{r}
 2,048 \\
 -2 \\
 \hline
 2,046
 \end{array}
 \qquad
 \begin{array}{r}
 32 \\
 -2 \\
 \hline
 30
 \end{array}$$

Custom Subnet Masks

Problem 8

Number of needed subnets **3**
 Number of needed usable hosts **45**
 Network Address **200.175.14.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 4

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 2

Show your work for Problem 8 in the space below.

	256	128	64	32	16	8	4	2	-	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	Binary values
200 . 175 . 14 .	0	0	0	0	0	0	0	0		

128	4	64
+64	-2	-2
240	2	62

Custom Subnet Masks

Problem 9

Number of needed subnets **60**
 Number of needed usable hosts **1,000**
 Network Address **128.77.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 252 . 0

Total number of subnets 64

Total number of host addresses 1,024

Number of usable addresses 1,022

Number of bits borrowed 6

Show your work for Problem 9 in the space below.

Number of Hosts	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536
Binary values	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
	128	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0

128		
64		
32		
16		
8	64	1,024
+4	-2	-2
252	62	1,022

Custom Subnet Masks

Problem 10

Number of needed usable hosts **60**

Network Address **198.100.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 4

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 2

Show your work for Problem 10 in the space below.

	256	128	64	32	16	8	4	2	1	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1		Binary values
198 . 100 . 10 .	0	0	0	0	0	0	0	0	0	

128	64	4
+64	-2	-2
192	62	2

Custom Subnet Masks

Problem 11

Number of needed subnets **250**

Network Address **101.0.0.0**

Address class A

Default subnet mask 255 . 0 . 0 . 0

Custom subnet mask 255 . 255 . 0 . 0

Total number of subnets 256

Total number of host addresses 65,536

Number of usable addresses 65,534

Number of bits borrowed 8

Show your work for Problem 11 in the space below.

Number of Hosts	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152	4194304	8388608	16777216	33554432	67108864	134217728	268435456	536870912	1073741824	2147483648	4294967296	8589934592	17179869184	34359738368	68719476736	137438953472	274877906944	549755813888	1099511627776	2199023255552	4398046511104	8796093022208	17592186044416	35184372088832	70368744177664	140737488355328	281474976710656	562949953421312	1125899906842624	2251799813685248	4503599627370496	9007199254740992	18014398509481984	36028797018963968	72057594037927936	144115188075855872	288230376151711744	576460752303423488	1152921504606846976	2305843009213693952	4611686018427387904	9223372036854775808	18446744073709551616	36893488147419103232	73786976294838206464	147573952589676412928	295147905179352825856	590295810358705651712	1180591620717411303424	2361183241434822606848	4722366482869645213696	9444732965739290427392	18889465931478580854784	37778931862957161709568	75557863725914323419136	151115727451828646838272	302231454903657293676544	604462909807314587353088	1208925819614629174706176	2417851639229258349412352	4835703278458516698824704	9671406556917033397649408	19342813113834066795298816	38685626227668133590597632	77371252455336267181195264	154742504910672534362390528	309485009821345068724781056	618970019642690137449562112	1237940039285380274899124224	2475880078570760549798248448	4951760157141521099596496896	9903520314283042199192993792	19807040628566084398385987584	39614081257132168796771975168	79228162514264337593543950336	158456325028528675187087900672	316912650057057350374175801344	633825300114114700748351602688	1267650600228229401496703205376	2535301200456458802993406410752	5070602400912917605986812821504	10141204801825835211973625643008	20282409603651670423947251286016	40564819207303340847894502572032	81129638414606681695789005144064	162259276829213363391578010288128	324518553658426726783156020576256	649037107316853453566312041152512	1298074214633706907132624082305024	2596148429267413814265248164610048	5192296858534827628530496329220096	10384593717069655257060992658440192	20769187434139310514121985316880384	41538374868278621028243970633760768	83076749736557242056487941267521536	166153499473114484112975882535043072	332306998946228968225951765070086144	664613997892457936451903530140172288	1329227995784915872903807060280344576	2658455991569831745807614120560689152	5316911983139663491615228241121378304	10633823966279326983230456482242756608	21267647932558653966460912964485513216	42535295865117307932921825928971026432	85070591730234615865843651857942052864	170141183460469231731687303715884105216	340282366920938463463374607431768210432	680564733841876926926749214863536420864	1361129467683753853853498429727072841728	2722258935367507707706996859454145683456	5444517870735015415413993718908291366912	10889035741470030830827987437816582733824	21778071482940061661655974875633165467648	43556142965880123323311949751266330935296	87112285931760246646623899502532661870592	174224571863520493293247799005065323541184	348449143727040986586495598010130647082368	696898287454081973172991196020261294164736	1393796574908163946345982392040522588329472	2787593149816327892691964784081045176658944	5575186299632655785383929568162090353317888	11150372599265311570767859136324180706635776	223007451985306231415357182726483614
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Custom Subnet Masks

Problem 12

Number of needed subnets **5**

Network Address **218.35.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

Show your work for Problem 12 in the space below.

	256	128	64	32	16	8	4	2	-	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	Binary values
218 . 35 . 50 .	0	0	0	0	0	0	0	0		

128		
64	64	4
+32	-2	-2
<u>224</u>	<u>62</u>	<u>2</u>

Custom Subnet Masks

Problem 13

Number of needed usable hosts **25**

Network Address **218.35.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

Show your work for Problem 13 in the space below.

		256	128	64	32	16	8	4	2	-	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256		
		128	64	32	16	8	4	2	1	-	Binary values
218 . 35 . 50 .		0	0	0	0	0	0	0	0		

128		
64	8	32
+32	-2	-2
224	6	30

Custom Subnet Masks

Problem 14

Number of needed subnets **10**

Network Address **172.59.0.0**

Address class **B**

Default subnet mask **255 . 255 . 0 . 0**

Custom subnet mask **255 . 255 . 240 . 0**

Total number of subnets **16**

Total number of host addresses **4,096**

Number of usable addresses **4,094**

Number of bits borrowed **4**

Show your work for Problem 14 in the space below.

Number of Hosts	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets	2	4	8	16	32	64	128	256	512	1024	2048	4096	8,192	16,384	32,768	65,536
Binary values	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
	172	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0

$$\begin{array}{r}
 128 \\
 64 \\
 32 \\
 +16 \\
 \hline
 240
 \end{array}
 \qquad
 \begin{array}{r}
 16 \\
 -2 \\
 \hline
 14
 \end{array}
 \qquad
 \begin{array}{r}
 4,096 \\
 -2 \\
 \hline
 4,094
 \end{array}$$

Custom Subnet Masks

Problem 15

Number of needed usable hosts **50**

Network Address **172.59.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

Show your work for Problem 15 in the space below.

										. 256	128	64	32	16	8	4	2
Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	.	512	1024	2048	4096	8192	16384	32768	65536
Number of Subnets -	2	4	8	16	32	64	128	256.		512	1024	2048	4096	8192	16384	32768	65536
Binary values -	128	64	32	16	8	4	2	1 .	128	64	32	16	8	4	2	1	
	172	. 59	. 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Handwritten calculations:

$$\begin{array}{r} 128 \\ 64 \\ 32 \\ 16 \\ 8 \\ 4 \\ 2 \\ \hline +1 \\ \hline 255 \end{array}$$

$$\begin{array}{r} 128 \\ 64 \\ \hline +64 \\ \hline 192 \end{array}$$

$$\begin{array}{r} 64 \\ 2 \\ \hline -2 \\ \hline 62 \end{array}$$

$$\begin{array}{r} 1,024 \\ 2 \\ \hline -2 \\ \hline 1,022 \end{array}$$

Custom Subnet Masks

Problem 16

Number of needed usable hosts **29**

Network Address **23.0.0.0**

Address class **A**

Default subnet mask **255 . 0 . 0 . 0**

Custom subnet mask **255 . 255 . 255 . 224**

Total number of subnets **524,288**

Total number of host addresses **32**

Number of usable addresses **30**

Number of bits borrowed **19**

Show your work for Problem 16 in the space below.

Number of Hosts	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152	4194304	8388608	16777216	33554432	67108864	134217728	268435456	536870912	1073741824	2147483648	4294967296	8589934592	17179869184	34359738368	68719476736	137438953472	274877906944	549755813888	1099511627776	2199023255552	4398046511104	8796093022208	17592186044416	35184372088832	70368744177664	140737488355328	281474976710656	562949953421312	1125899906842624	2251799813685248	4503599627370496	9007199254740992	18014398509481984	36028797018963968	72057594037927936	144115188075855872	288230376151711744	576460752303423488	1152921504606846976	2305843009213693952	4611686018427387904	9223372036854775808	18446744073709551616	36893488147419103232	73786976294838206464	147573952589676412928	295147905179352825856	590295810358705651712	1180591620717411303424	2361183241434822606848	4722366482869645213696	9444732965739290427392	18889465931478580854784	37778931862957161709568	75557863725914323419136	151115727451828646838272	302231454903657293676544	604462909807314587353088	1208925819614629174706176	2417851639229258349412352	4835703278458516698824704	9671406556917033397649408	19342813113834066795298816	38685626227668133590597632	77371252455336267181195264	154742504910672534362390528	309485009821345068724781056	618970019642690137449562112	1237940039285380274899124224	2475880078570760549798248448	4951760157141521099596496896	9903520314283042199192993792	19807040628566084398385987584	39614081257132168796771975168	79228162514264337593543950336	158456325028528675187087900672	316912650057057350374175801344	633825300114114700748351602688	1267650600228229401496703205376	2535301200456458802993406410752	5070602400912917605986812821504	10141204801825835211973625643008	20282409603651670423947251286016	40564819207303340847894502572032	81129638414606681695789005144064	162259276829213363391578010288128	324518553658426726783156020576256	649037107316853453566312041152512	1298074214633706907132624082305024	2596148429267413814265248164610048	5192296858534827628530496329220096	10384593717069655257060992658440192	20769187434139310514121985316880384	41538374868278621028243970633760768	83076749736557242056487941267521536	166153499473114484112975882535043072	332306998946228968225951765070086144	664613997892457936451903530140172288	1329227995784915872903807060280344576	2658455991569831745807614120560689152	5316911983139663491615228241121378304	10633823966279326983230456482242756608	21267647932558653966460912964485513216	42535295865117307932921825928971026432	85070591730234615865843651857942052864	170141183460469231731687303715884105728	340282366920938463463374607431768211456	680564733841876926926749214863536422912	1361129467683753853853498429727072845824	272225893536750770770699685945414569152	544451787073501541541399371890829138304	1088903574147003083082798743781658276608	2177807148294006166165597487563316553216	4355614296588012332331194975126633106432	8711228593176024664662389950253266212864	17422457186352049329324779900506532425728	34844914372704098658649559801013064851456	69689828745408197317299119602026129702912	139379657490816394634598239204052259405824	278759314981632789269196478408104518811648	557518629963265578538392956816209037623296	1115037259926531157076785913632418075246592	2230074519853062314153571827264836150493184	4460149039706124628307143654529672300986368	8920298079412249256614287309059344601972736	17840596158824498513228574618118689203945472	35681192317648997026457149236237378407890848	71362384635297994052914298472474756815781696	142724769270595988105828596944949513631563392	285449538541191976211657193889899027263126784	570899077082383952423314387779798054526253568	1141798154164767904846628775559596109052507136	2283596308329535809693257551119192218105014272	4567192616659071619386515102238384436210028544	9134385233318143238773030204476768872420057088	18268770466636286477546060408953537744840114176	36537540933272572955092120817907075489680228352	73075081866545145910184241635814150979360456704	146150163733090291820368483271628301958720913408	292300327466180583640736966543256603917441826816	584600654932361167281473933086513207834883653632	1169201309864722334562947866173026415669767307264	2338402619729444669125895732346052831339534614528	4676805239458889338251791464692105662679069229056	9353610478917778676503582929384211325358138458112	18707220957835557353007165858768422650716276916224	37414441915671114706014331717536845301432553832448	74828883831342229412028663435073690602865107664896	149657767662684458824057326870147381205730215329792	299315535325368917648114653740294762411460430659584	598631070650737835296229307480589524822920861319168	1197262141301475670592458614961179049645841722638336	2394524282602951341184917229922358099291683445276672	4789048565205902682369834459844716198583366890553344	9578097130411805364739668919689432397166733781106688	19156194260823610729479337839378864794333467562213376	38312388521647221458958675678757729588666935124426752	76624777043294442917917351357515459177333870248853504	153249554086588885835834702715030918354667740497707008	306499108173177771671669405430061836709335480995414016	612998216346355543343338810860123673418670961990828032	1225996432692711086686677621720247346837341923981665664	24519928653854221733733552434404946936746838479633312	49039857307708443467467104868809893873493676959266624	98079714615416886934934209737619787746987353918533248	196159429230833773869868419475239575493974707837066496	392318858461667547739736838950479150987949415674132992	784637716923335095479473677900958301975898831348265984	1569275433846670190958947355801916603951797662696531968	3138550867693340381917894711603833207903595325393063936	6277101735386680763835789423207666415807190650786127872	12554203470773361527671578846415332831614381301572255744	25108406941546723055343157692830665663228762603144511488	50216813883093446110686315385661331326457525206289022976	100433627766186892221372630771322662652915050412578045952	200867255532373784442745261542645325305830100825156101104	401734511064747568885490523085290650611660201650312202208	803469022129495137770981046170581301223320403300624404416	1606938044258990275541962092341162602446640806601248808832	3213876088517980551083924184682325204893281613202497617664	6427752177035961102167848369364650409786563226404995235328	12855504354071922204335696738729300819573126452809904706656	25711008708143844408671393477458601639146252905619809413312	51422017416287688817342786954917203278292505811239618826624	102844034832575377634685573909834406556585011622479237653248	205688069665150755269371147819668813113170023244958475306496	411376139330301510538742295639337626226340046489916950612992	822752278660603021077484591278675252452680092979833901225984	1645504557321206042154969182557350504905360185959667802451968	3291009114642412084309938365114701009810720371919335604903936	6582018229284824168619876730229402019621440743838671209807872	13164036458569648337239753460458804039242881487677342419615744	26328072917139296674479506920917608078485762975354684839231488	52656145834278593348959013841835216156971525950709369678462976	105312291668557186697918027683670432313943051901418739356925952	210624583337114373395836055367340864627886103802837478713851904	421249166674228746791672110734681729255772207605674957427703808	842498333348457493583344221469363458511544415211349914855407616	1684996666696914987166688442938726917023088830422699829710815232	3369993333393829974333376885877453834046177660845399659421630464	6739986666787659948666753771754907668092355321690799318843260928	13479973333575319897333507543509815336184710643381598637686521856	26959946667150639794667015087019630672369421286763197275373043712	53919893334301279589334030174039261344738842573526394550746087424	107839786668602559178668060348078522689477685147052789101492174848	215679573337205118357336120696157045378955370294105578202984349696	431359146674410236714672241392314090757910740588211156405968699392	862718293348820473429344482784628181515821481176422312811937398784	1725436586697640946858688965569256363031642962352844625623874797568	3450873173395281893717377931138512726063285924705689251247749595136	6901746346790563787434755862277025452126571849411378502495499190272	13803492693581127574869511724554050904253143698822757004990998380544	27606985387162255149739023449108101808506287397645514009981996761088	55213970774324510299478046898216203617012574795291028019963993522176	110427941548649020598956093796432407234025149590582056039927987044352	220855883097298041197912187592864814468050299181164112079855974088704	441711766194596082395824375185729628936100598362328224159711948177408	883423532389192164791648750371459257872201196724656448319423896354816	1766847064778384329583297500742918515744402393449312896638847792709632	3533694129556768659166595001485837031488804786898625793277695585419264	7067388259113537318333190002971674062977609573797251586555391170838528	14134776518227074636666380005943348125955219147594503173110782341677056	28269553036454149273332760011886696251910438295189006346221564683354112	56539106072908298546665520023773392503820876590378012692443129366708224	113078212145816597093331040047546785007641753180756025384886258733416448	226156424291633194186662080095093570015283506361512050769772517466832896	452312848583266388373324160190187140030567012723024101539545034933665792	904625697166532776746648320380374280061134025446048203079090069867331584	1809251394333065553493296640760748560122268050892096406158180139734663168	3618502788666131106986593281521497120244536101784192812316360279469326336	7237005577332262213973186563042994240489072203568385624632720558938652672	14474011154664524427946373126085988480978144407136771249265441117877305344	28948022309329048855892746252171976961956288814273542498530882235754610688	57896044618658097711785492504343953923912577628547084997061764471509221376	115792089237316195423570985008687907847825155257094169994123528943018442752	231584178474632390847141970017375815695650310514188339988247057886036885504	463168356949264781694283940034751631391300621028376679976494115772073771008	926336713898529563388567880069503262782601242056753359952988231544147542016	1852673427797059126777135760139006525565202484113506719905976463088284084032	3705346855594118253554271520278013051130404968227013439811952926176568168064	7410693711188236507108543040556026102260809936454026879623905852353136336128	14821387422376473014217086081112052204521619872908053759247811704706272672256	29642774844752946028434172162224104409043239745816107518495623409412545344512	5928554968950589
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Subnetting

Problem 1

Number of needed subnets **14**

Number of needed usable hosts **14**

Network Address **192.10.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 240

Total number of subnets 16

Total number of host addresses 16

Number of usable addresses 14

Number of bits borrowed 4

What is the 4th subnet range? 192.10.10.48 to 192.10.10.63

What is the subnet number for the 8th subnet? 192 . 10 . 10 . 112

What is the subnet broadcast address for the 13th subnet? 192 . 10 . 10 . 207

What are the assignable addresses for the 9th subnet? 192.10.10.129 to 192.10.10.142

Show your work for Problem 1 in the space below.

Number of Subnets	256 128 64 32				16 8 4 2				Number of Hosts	
	2	4	8	16	32	64	128	256		
	128	64	32	16	8	4	2	1	Binary values	
192.10.10.0	0	0	0	0	0	0	0	0		
(1)	0	0	0	0	192.10.10.0				to	192.10.10.15
(2)	0	0	0	1	192.10.10.16				to	192.10.10.31
(3)	0	0	1	0	192.10.10.32				to	192.10.10.47
(4)	0	0	1	1	192.10.10.48				to	192.10.10.63
(5)	0	1	0	0	192.10.10.64				to	192.10.10.79
(6)	0	1	0	1	192.10.10.80				to	192.10.10.95
(7)	0	1	1	0	192.10.10.96				to	192.10.10.111
(8)	0	1	1	1	192.10.10.112				to	192.10.10.127
(9)	1	0	0	0	192.10.10.128				to	192.10.10.143
(10)	1	0	0	1	192.10.10.144				to	192.10.10.159
(11)	1	0	1	0	192.10.10.160				to	192.10.10.175
(12)	1	0	1	1	192.10.10.176				to	192.10.10.191
(13)	1	1	0	0	192.10.10.192				to	192.10.10.207
(14)	1	1	0	1	192.10.10.208				to	192.10.10.223
(15)	1	1	1	0	192.10.10.224				to	192.10.10.239
(16)	1	1	1	1	192.10.10.240				to	192.10.10.255

$$\begin{array}{r}
 128 \\
 64 \\
 32 \\
 +16 \\
 \hline
 \text{Custom subnet mask } 240
 \end{array}$$

$$\begin{array}{r}
 16 \\
 -2 \\
 \hline
 \text{Usable subnets } 14
 \end{array}$$

$$\begin{array}{r}
 16 \\
 -2 \\
 \hline
 \text{Usable hosts } 14
 \end{array}$$

The binary value of the last bit borrowed is the range. In this problem the range is 16.

The first address in each subnet range is the subnet number.

The last address in each subnet range is the subnet broadcast address.

Subnetting

Problem 2

Number of needed subnets **1000**

Number of needed usable hosts **60**

Network Address **165.100.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

What is the 15th subnet range? 165.100.3.128 to 165.100.3.191

What is the subnet number for the 6th subnet? 165 . 100 . 1 . 64

What is the subnet broadcast address for the 6th subnet? 165 . 100 . 1 . 127

What are the assignable addresses for the 9th subnet? 165.100.2.1 to 165.100.0.62

Show your work for Problem 2 in the space below.

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets -	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536
Binary values -	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
165 . 100 . 0 0 0 0 0 0 0 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Usable hosts	64	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2
	-2															
	62															

Custom subnet mask	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
	+64															
	192															
	+1															
	255															

The binary value of the last bit borrowed is the range. In this problem the range is 64.

The first address in each subnet range is the subnet number.

The last address in each subnet range is the subnet broadcast address.

(1)	165.100.0.0	to	165.100.0.63
(2)	165.100.0.64	to	165.100.0.127
(3)	165.100.0.128	to	165.100.0.191
(4)	165.100.0.192	to	165.100.0.255
(5)	165.100.1.0	to	165.100.1.63
(6)	165.100.1.64	to	165.100.1.127
(7)	165.100.1.128	to	165.100.1.191
(8)	165.100.1.192	to	165.100.1.255
(9)	165.100.2.0	to	165.100.2.63
(10)	165.100.2.64	to	165.100.2.127
(11)	165.100.2.128	to	165.100.2.191
(12)	165.100.2.192	to	165.100.2.255
(13)	165.100.3.0	to	165.100.3.63
(14)	165.100.3.64	to	165.100.3.127
(15)	165.100.3.128	to	165.100.3.191
(16)	165.100.3.192	to	165.100.3.255

Down to

(1023)	165.100.255.128	to	165.100.255.191
(1024)	165.100.255.192	to	165.100.255.255

Subnetting

Problem 3

Hint: It is possible to borrow one bit to create two subnets.

Number of needed subnets **2**

Network Address **195.223.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 128

Total number of subnets 2

Total number of host addresses 128

Number of usable addresses 126

Number of bits borrowed 1

What is the 2nd subnet range? 195.223.50.128 - 195.223.50.255

What is the subnet number for the 2nd subnet? 195.223.50.128

What is the subnet broadcast address for the 1st subnet? 195.223.50.127

What are the assignable addresses for the 1st subnet? 195.223.50.1 - 195.223.50.126

Show your work for Problem 3 in the space below.

		256	128	64	32	16	8	4	2	-	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256		
		128	64	32	16	8	4	2	1	-	Binary values
195.223.50.0		0	0	0	0	0	0	0	0		
(1)	0	195.223.50.0 to 195.223.50.127									
(2)	1	195.223.50.128 to 195.223.50.255									

Subnetting

Problem 4

Number of needed subnets **750**

Network Address **190.35.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

What is the 15th subnet range? 190.35.3.128 to 190.35.3.191

What is the subnet number for the 13th subnet? 190.35.3.0

What is the subnet broadcast address for the 10th subnet? 190.35.2.127

What are the assignable addresses for the 6th subnet? 190.35.1.65 to 190.35.1.126

Show your work for Problem 4 in the space below.

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets -	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Binary values -	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
190.35.0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0	190.35.0.0
(2)	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64	190.35.0.64
(3)	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128	190.35.0.128
(4)	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192	190.35.0.192
(5)	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0	190.35.1.0
(6)	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64	190.35.1.64
(7)	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128	190.35.1.128
(8)	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192	190.35.1.192
(9)	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0	190.35.2.0
(10)	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64	190.35.2.64
(11)	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128	190.35.2.128
(12)	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192	190.35.2.192
(13)	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0	190.35.3.0
(14)	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64	190.35.3.64
(15)	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128	190.35.3.128
(16)	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192	190.35.3.192

Subnetting

Problem 5

Number of needed usable hosts **6**

Network Address **126.0.0.0**

Address class A

Default subnet mask 255 . 0 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 248

Total number of subnets 2,097,152

Total number of host addresses 8

Number of usable addresses 6

Number of bits borrowed 21

What is the 2nd subnet range? 126.0.0.8 to 126.0.0.15

What is the subnet number for the 5th subnet? 126.0.0.32

What is the subnet broadcast address for the 7th subnet? 126.0.0.55

What are the assignable addresses for the 10th subnet? 126.0.0.73 to 126.0.0.78

Show your work for Problem 5 in the space below.

Number of Hosts	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152	4194304
Number of Subnets	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152	4194304
Binary values	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4
	126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)						
	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to						
	126.0.0.7	126.0.0.15	126.0.0.23	126.0.0.31	126.0.0.39	126.0.0.47	126.0.0.55	126.0.0.63	126.0.0.71	126.0.0.79	126.0.0.87	126.0.0.95	126.0.0.103	126.0.0.111	126.0.0.119	126.0.0.127						

Subnetting

Problem 6

Number of needed subnets **10**

Network Address **192.70.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 240

Total number of subnets 16

Total number of host addresses 16

Number of usable addresses 14

Number of bits borrowed 4

What is the 9th subnet range? 192.70.10.128 to 192.70.10.143

What is the subnet number for the 4th subnet? 192.70.10.48

What is the subnet broadcast address for the 12th subnet? 192.70.10.191

What are the assignable addresses for the 10th subnet? 192.70.10.145 to 192.70.10.158

Show your work for Problem 6 in the space below.

												Number of
								256	128	64	32	Hosts
Number of Subnets								2	4	8	16	
								128	64	32	16	
192 . 70 . 10 .								0	0	0	0	
								8	4	2	1	Binary values
								0	0	0	0	
(1)							0	192.70.10.0	to	192.70.10.15		
(2)							1	192.70.10.16	to	192.70.10.31		
(3)				1	0			192.70.10.32	to	192.70.10.47		
(4)				1	1			192.70.10.48	to	192.70.10.63		
(5)			1	0	0			192.70.10.64	to	192.70.10.79		
(6)			1	0	1			192.70.10.80	to	192.70.10.95		
(7)			1	1	0			192.70.10.96	to	192.70.10.111		
(8)			1	1	1			192.70.10.112	to	192.70.10.127		
(9)	1	0	0	0				192.70.10.128	to	192.70.10.143		
(10)	1	0	0	1				192.70.10.144	to	192.70.10.159		
(11)	1	0	1	0				192.70.10.160	to	192.70.10.175		
(12)	1	0	1	1				192.70.10.176	to	192.70.10.191		
(13)	1	1	0	0				192.70.10.192	to	192.70.10.207		
(14)	1	1	0	1				192.70.10.208	to	192.70.10.223		
(15)	1	1	1	0				192.70.10.224	to	192.70.10.239		
(16)	1	1	1	1				192.70.10.240	to	192.70.10.255		

$$\begin{array}{r}
 128 \\
 +64 \\
 \hline
 240
 \end{array}
 \qquad
 \begin{array}{r}
 16 \\
 -2 \\
 \hline
 14
 \end{array}$$

Subnetting

Problem 7

Network Address **10.0.0.0 /16**

Address class A

Default subnet mask 255 . 0 . 0 . 0

Custom subnet mask 255 . 255 . 0 . 0

Total number of subnets 256

Total number of host addresses 65,536

Number of usable addresses 65,534

Number of bits borrowed 8

What is the 11th subnet range? 10.10.0.0 to 10.10.255.255

What is the subnet number for the 6th subnet? 10.5.0.0

What is the subnet broadcast address for the 2nd subnet? 10.1.255.255

What are the assignable addresses for the 9th subnet? 10.8.0.1 to 10.8.255.254

Show your work for Problem 7 in the space below.

Number of Hosts	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072
Number of Subnets	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144
Binary values	128	64	32	16	8	4	2	1	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)		
128																		
64																		
32																		
16																		
8																		
4																		
2																		
+1																		
255																		
															</			

Subnetting

Problem 8

Number of needed subnets **5**

Network Address **172.50.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 224 . 0

Total number of subnets 8

Total number of host addresses 8,192

Number of usable addresses 8,190

Number of bits borrowed 3

What is the 4th subnet range? 172.50.96.0 to 172.50.127.255

What is the subnet number for the 5th subnet? 172.50.128.0

What is the subnet broadcast address for the 6th subnet? 172.50.191.255

What are the assignable addresses for the 3rd subnet? 172.50.64.1 to 172.50.95.254

Show your work for Problem 8 in the space below.

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets -	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Binary values -	128	64	32	16	8	4	2	1	1	128	64	32	16	8	4	2
	172	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	0	172	50	0	0	0	0	0	to	172	50	0	31	255		
(2)	1	172	50	0	32	0	0	0	to	172	50	0	63	255		
(3)	1	172	50	0	64	0	0	0	to	172	50	0	95	255		
(4)	1	172	50	0	96	0	0	0	to	172	50	0	127	255		
(5)	1	172	50	0	128	0	0	0	to	172	50	0	159	255		
(6)	1	172	50	0	160	0	0	0	to	172	50	0	191	255		
(7)	1	172	50	0	192	0	0	0	to	172	50	0	223	255		
(8)	1	172	50	0	224	0	0	0	to	172	50	0	255	255		

128

64

+32

224

8,192

-2

8,190

Subnetting

Problem 9

Number of needed usable hosts **28**

Network Address **172.50.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 2,048

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 11

What is the 2nd subnet range? 172.50.0.32 to 172.50.0.63

What is the subnet number for the 10th subnet? 172.50.1.32

What is the subnet broadcast address for the 4th subnet? 172.50.0.127

What are the assignable addresses for the 6th subnet? 172.50.0.161 to 172.50.0.190

Show your work for Problem 9 in the space below.

[illegible]

Subnetting

Problem 10

Number of needed subnets **45**

Network Address **220.100.100.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 252

Total number of subnets 64

Total number of host addresses 4

Number of usable addresses 2

Number of bits borrowed 6

What is the 5th subnet range? 220.100.100.16 to 220.100.100.19

What is the subnet number for the 4th subnet? 220.100.100.12

What is the subnet broadcast address for the 13th subnet? 220.100.100.51

What are the assignable addresses for the 12th subnet? 220.100.100.45 to 220.100.100.46

Show your work for Problem 10 in the space below.

Number of Subnets				Number of Hosts			
256	128	64	32	16	8	4	2
-	2	4	8	16	32	64	128
128	64	32	16	8	4	2	1
220 . 100 . 100 .	0	0	0	0	0	0	0
Binary values							
(1)	0					220.100.100.0	to 220.100.100.3
(2)	1					220.100.100.4	to 220.100.100.7
(3)		1				220.100.100.8	to 220.100.100.11
(4)		1				220.100.100.12	to 220.100.100.15
(5)		1	0	0		220.100.100.16	to 220.100.100.19
(6)		1	0	0	1	220.100.100.20	to 220.100.100.23
(7)		1	1	0	0	220.100.100.24	to 220.100.100.27
(8)		1	1	1	1	220.100.100.28	to 220.100.100.31
(9)	1	0	0	0	0	220.100.100.32	to 220.100.100.35
(10)	1	0	0	0	1	220.100.100.36	to 220.100.100.39
(11)	1	0	1	0	0	220.100.100.40	to 220.100.100.43
(12)	1	0	1	1	1	220.100.100.44	to 220.100.100.47
(13)	1	1	0	0	0	220.100.100.48	to 220.100.100.51
(14)	1	1	0	1	1	220.100.100.52	to 220.100.100.55
(15)	1	1	1	1	0	220.100.100.56	to 220.100.100.59
(16)	1	1	1	1	1	220.100.100.60	to 220.100.100.63

128
64
32
16
8
+4
252

4
-2
2

Subnetting

Problem 11

Number of needed usable hosts **8,000**

Network Address **135.70.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 224 . 0

Total number of subnets 8

Total number of host addresses 8,192

Number of usable addresses 8,190

Number of bits borrowed 3

What is the 6th subnet range? 135.70.160.0 to 135.70.191.255

What is the subnet number for the 7th subnet? 135.70.192.0

What is the subnet broadcast address for the 3rd subnet? 135.70.95.255

What are the assignable addresses for the 5th subnet? 135.70.128.1 to 135.70.159.254

Show your work for Problem 11 in the space below.

[illegible]

Subnetting

Problem 12

Number of needed usable hosts **45**

Network Address **198.125.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 4

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 2

What is the 2nd subnet range? 198.125.50.64 to 198.125.50.127

What is the subnet number for the 2nd subnet? 198.125.50.64

What is the subnet broadcast address for the 4th subnet? 198.125.50.255

What are the assignable addresses for the 3rd subnet? 198.125.50.129 to 198.125.50.190

Show your work for Problem 12 in the space below.

												Number of	
				256	128	64	32	16	8	4	2	1	Hosts
Number of Subnets				-	2	4	8	16	32	64	128	256	
				128	64	32	16	8	4	2	1	-	Binary values
198 . 125 . 50 .				0	0	0	0	0	0	0	0	0	
(1)				0	198.125.50.0 to 198.125.50.63								
(2)				1	198.125.50.64 to 198.125.50.127								
(3)				1	0	198.125.50.128 to 198.125.50.191							
(4)				1	1	198.125.50.192 to 198.125.50.255							

$$\begin{array}{r} 128 \\ +64 \\ \hline 192 \end{array}$$

$$\begin{array}{r} 64 \\ -2 \\ \hline 62 \end{array}$$

Subnetting

Problem 13

Network Address **165.200.0.0 /26**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

What is the 10th subnet range? 165.200.2.64 to 165.200.2.127

What is the subnet number for the 11th subnet? 165.200.2.128

What is the subnet broadcast address for the 1023rd subnet? 165.200.255.191

What are the assignable addresses for the 1022nd subnet? 165.200.255.65 to 165.200.255.126

Show your work for **Problem 13** in the space below.

Number of Hosts	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets	2	4	8	16	32	64	128	256	512	1024						
Binary values	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
165.200.0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
to	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
165.200.0.63																
to	64	32	16	8	4	2	1									
165.200.0.127																
to	32	16	8	4	2	1										
165.200.0.191																
to	16	8	4	2	1											
165.200.0.255																
to	8	4	2	1												
165.200.1.63																
to	4	2	1													
165.200.1.127																
to	2	1														
165.200.1.191																
to	1															
165.200.1.255																
to	0															
165.200.2.63																
to	64	32	16	8	4	2	1									
165.200.2.127																
to	32	16	8	4	2	1										
165.200.2.191																
to	16	8	4	2	1											
165.200.2.255																
to	8	4	2	1												
165.200.3.63																
to	4	2	1													
165.200.3.127																
to	2	1														
165.200.3.191																
to	1															
165.200.3.255																
to	0															
165.200.255.64																
to	128	64	32	16	8	4	2	1								
165.200.255.127																
to	64	32	16	8	4	2	1									
165.200.255.191																
to	32	16	8	4	2	1										
165.200.255.255																
to	16	8	4	2	1											
165.200.255.255																
to	8	4	2	1												
165.200.255.255																
to	4	2	1													
165.200.255.255																
to	2	1														
165.200.255.255																
to	1															
165.200.255.255																
to	0															

Subnetting

Problem 14

Number of needed usable hosts **16**

Network Address **200.10.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

What is the 7th subnet range? 200.10.10.192 to 200.10.10.223

What is the subnet number for the 5th subnet? 200.10.10.128

What is the subnet broadcast address for the 4th subnet? 200.10.10.127

What are the assignable addresses for the 6th subnet? 200.10.10.161 to 200.10.10.190

Show your work for Problem 14 in the space below.

Number of Subnets	256 128 64				32 16 8 4 2					Number of Hosts	
	-	2	4	8	16	32	64	128	256		
		128	64	32	16	8	4	2	1	Binary values	
<u>200 . 10 . 10 . 0 0 0</u>											
(1)				0	200.10.10.0					to	200.10.10.31
(2)				1	200.10.10.32					to	200.10.10.63
(3)			1	0	200.10.10.64					to	200.10.10.95
(4)			1	1	200.10.10.96					to	200.10.10.127
(5)	1	0	0		200.10.10.128					to	200.10.10.159
(6)	1	0	1		200.10.10.160					to	200.10.10.191
(7)	1	1	0		200.10.10.192					to	200.10.10.223
(8)	1	1	1		200.10.10.224					to	200.10.10.255

128	
64	32
+32	-2
<u>224</u>	<u>30</u>

Subnetting

Problem 15

Network Address **93.0.0.0 /19**

Address class A

Default subnet mask 255 . 0 . 0 . 0

Custom subnet mask 255 . 255 . 224 . 0

Total number of subnets 2,048

Total number of host addresses 8,192

Number of usable addresses 8,190

Number of bits borrowed 11

What is the 15th subnet range? 93.1.192.0 to 93.1.223.255

What is the subnet number for the 9th subnet? 93.1.0.0

What is the subnet broadcast address for the 7th subnet? 93.0.223.255

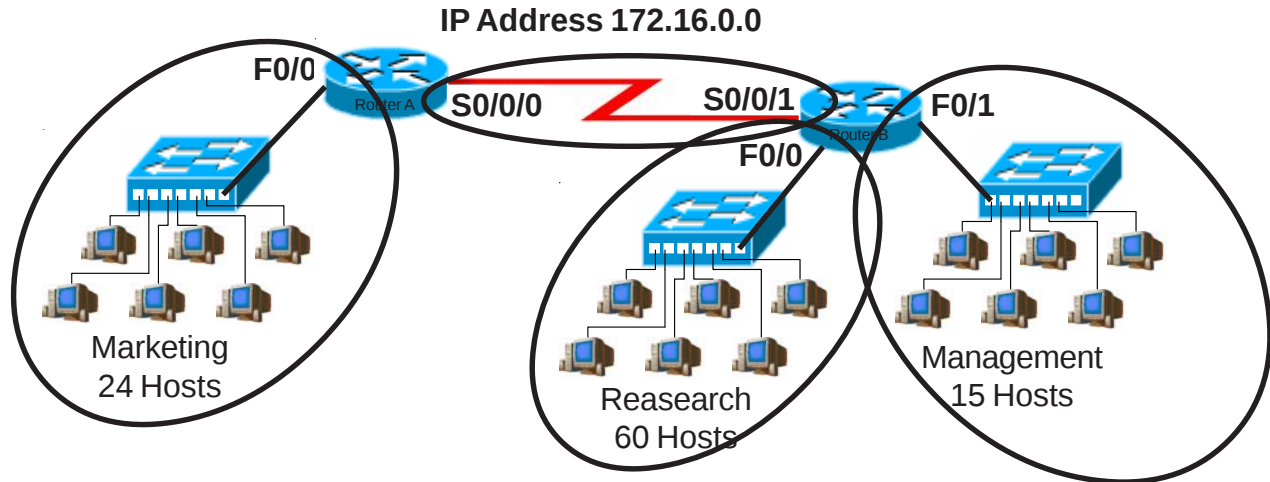
What are the assignable addresses for the 12th subnet? 93.1.96.1 to 93.1.127.254

Show your work for **Problem 15** in the space below.

Number of Hosts	1	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536	131,072	262,144	524,288	1,048,576	2,097,152	4,194,304	8,388,608	16,777,216	33,554,432	67,108,864	134,217,728	268,435,456	536,870,912	1,073,741,824	2,147,483,648	4,294,967,296	8,589,934,592	17,179,869,184	34,359,738,368	68,719,476,736	137,438,953,472	274,877,906,944	549,755,813,888	1,099,511,627,776	2,199,023,255,552	4,398,046,511,104	8,796,093,022,208	17,592,186,044,416	35,184,372,088,832	70,368,744,177,664	140,737,488,355,328	281,474,976,710,656	562,949,953,421,312	1,125,899,906,842,624	2,251,799,813,685,248	4,503,599,627,370,496	9,007,199,254,740,992	18,014,398,509,481,984	36,028,797,018,963,968	72,057,594,037,927,936	144,115,188,075,855,872	288,230,376,151,711,744	576,460,752,303,423,488	1,152,921,504,606,846,976	2,305,843,009,213,693,952	4,611,686,018,427,387,904	9,223,372,036,854,775,808	18,446,744,073,709,551,616	36,893,488,147,419,103,232	73,786,976,294,838,206,464	147,573,952,589,676,412,928	295,147,905,179,352,825,856	590,295,810,358,705,651,712	1,180,591,620,717,411,303,424	2,361,183,241,434,822,606,848	4,722,366,482,869,645,213,696	9,444,732,965,739,290,427,392	18,889,465,931,478,580,844,784	37,778,931,862,957,161,689,568	75,557,863,725,914,323,379,136	151,115,727,451,828,646,758,272	302,231,454,903,657,293,516,544	604,462,909,807,314,587,033,088	1,208,925,819,614,629,174,066,176	2,417,851,639,229,258,348,132,352	4,835,703,278,458,516,696,264,704	9,671,406,556,917,033,392,529,408	19,342,813,113,834,066,785,058,816	38,685,626,227,668,133,570,117,632	77,371,252,455,336,267,141,235,264	154,742,504,910,672,534,282,470,528	309,485,009,821,345,068,564,941,056	618,970,019,642,690,137,129,082,112	1,237,940,039,285,380,274,258,164,224	2,475,880,078,570,760,548,516,328,448	4,951,760,157,141,521,097,032,656,896	9,903,520,314,283,042,194,065,313,792	19,807,040,628,566,084,388,130,627,584	39,614,081,257,132,168,776,261,255,168	79,228,162,514,264,337,552,522,510,336	158,456,325,028,528,675,105,105,020,672	316,912,650,057,057,350,210,210,041,344	633,825,300,114,114,700,420,420,082,688	1,267,650,600,228,229,400,840,840,165,376	2,535,301,200,456,458,801,681,680,330,752	5,070,602,400,912,917,603,363,360,661,504	10,141,204,801,825,835,206,726,720,122,300,808	20,282,409,603,651,670,413,453,440,244,601,616	40,564,819,207,303,340,826,906,880,489,203,232	81,129,638,414,606,681,653,813,770,978,406,464	162,259,276,829,213,363,307,627,541,956,812,928	324,518,553,658,426,726,615,255,083,903,645,856	649,037,107,316,853,453,230,510,167,807,291,712	1,298,074,214,633,706,906,460,020,335,614,583,424	2,596,148,429,267,413,812,920,040,671,229,146,848	5,192,296,858,534,827,625,845,080,134,242,293,696	10,384,593,717,069,655,251,690,168,268,484,587,392	20,769,187,434,139,310,503,380,336,536,974,974,784	41,538,374,868,278,621,006,760,673,073,949,958,568	83,076,749,736,557,242,013,521,346,147,899,917,136	166,153,499,473,114,484,027,042,692,295,795,834,272	332,306,998,946,228,968,054,185,384,591,581,544	664,613,997,892,457,936,108,370,769,183,163,088	1,329,227,995,784,915,872,216,740,538,366,326,176	2,658,455,991,569,831,744,433,481,076,732,352	5,316,911,983,139,663,488,866,962,153,464,704	10,633,823,966,279,326,977,733,924,306,929,408	21,267,647,932,558,653,955,467,848,613,858,816	42,535,295,865,117,307,910,935,697,227,717,632	85,070,591,730,234,615,821,871,394,455,435,264	170,141,183,460,469,231,643,742,788,910,870,528	340,282,366,920,938,463,287,485,577,821,741,056	680,564,733,841,876,926,574,971,155,643,482,112	1,361,
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Practical Subnetting 1

Based on the information in the graphic shown, design a network addressing scheme that will supply the minimum number of subnets, and allow enough extra subnets and hosts for 100% growth in both areas. Circle each subnet on the graphic and answer the questions below.



Address class	<i>B</i>
Custom subnet mask	<i>255.255.224.0</i>
Minimum number of subnets needed	<i>4</i>
Extra subnets required for 100% growth (Round up to the next whole number)	<i>+</i> <i>4</i>
Total number of subnets needed	<i>=</i> <i>8</i>
Number of host addresses in the largest subnet group	<i>60</i>
Number of addresses needed for 100% growth in the largest subnet (Round up to the next whole number)	<i>+</i> <i>60</i>
Total number of address needed for the largest subnet	<i>=</i> <i>120</i>

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

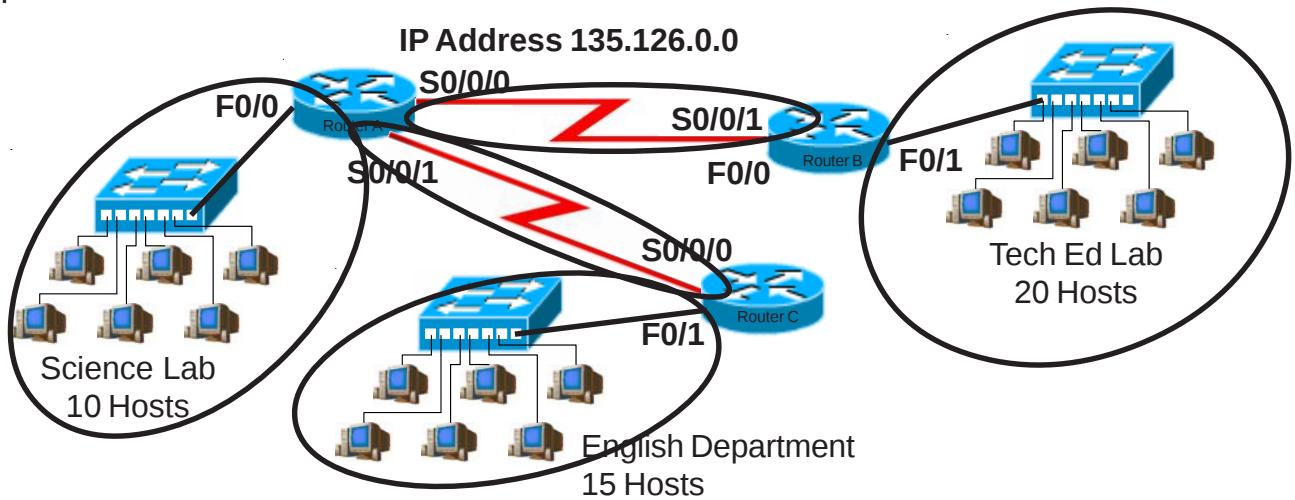
IP address range for Research	<i>172.16.0.0 to 172.31.255</i>
IP address range for Marketing	<i>172.16.32.0 to 172.63.255</i>
IP address range for Management	<i>172.16.64.0 to 172.95.255</i>
IP address range for Router A to Router B serial connection	<i>172.16.96.0 to 172.127.255</i>

Show your work for Practical Subnetting 1 in the space below.

[illegible]

Practical Subnetting 2

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 30% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Address class	<u>B</u>
Custom subnet mask	<u>255.255.255.224</u>
Minimum number of subnets needed	<u>5</u>
Extra subnets required for 30% growth (Round up to the next whole number)	<u>+ 2</u>
Total number of subnets needed	<u>= 7</u>
Number of host addresses in the largest subnet group	<u>20</u>
Number of addresses needed for 30% growth in the largest subnet (Round up to the next whole number)	<u>+ 6</u>
Total number of address needed for the largest subnet	<u>= 26</u>

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

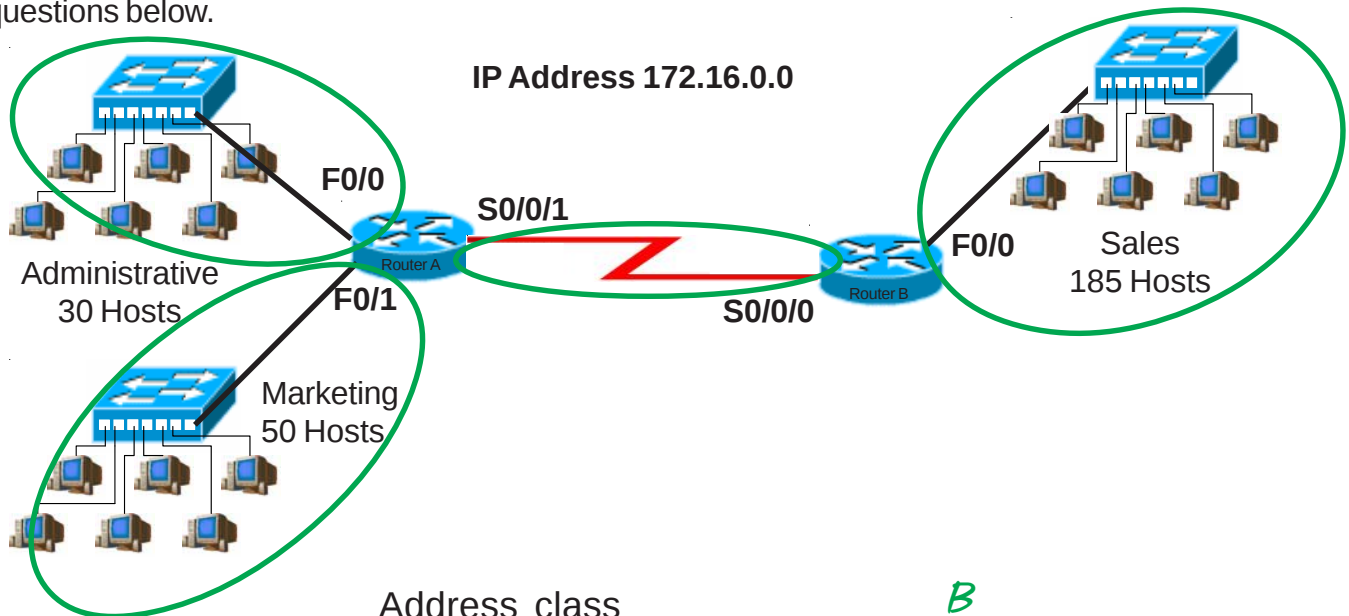
IP address range for Tech Ed	<u>135.126.0.0 to 135.126.0.31</u>
IP address range for English	<u>135.126.0.32 to 135.126.0.63</u>
IP address range for Science	<u>135.126.0.64 to 135.126.0.95</u>
IP address range for Router A to Router B serial connection	<u>135.126.0.96 to 135.126.0.127</u>
IP address range for Router A to Router B serial connection	<u>135.126.0.128 to 135.126.0.159</u>

Show your work for Problem 2 in the space below.

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets -	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Binary values -	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
135.126.0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	0															to
(2)	1															to
(3)	1	0														to
(4)	1	1														to
(5)	1	0	0													to
(6)	1	0	1													to
(7)	1	1	0													to
(8)	1	1	1													to
(9)	1	0	0	0												to
(10)	1	0	0	1												to
(11)	1	0	1	0												to
(12)	1	0	1	1												to
(13)	1	1	0	0												to
(14)	1	1	0	1												to
(15)	1	1	1	0												to
(16)	1	1	1	1												to
5																135.126.0.31
x.3																135.126.0.63
1.5																135.126.0.95
(Round up to 2)																135.126.0.127
20																135.126.0.159
x.3																135.126.0.191
6																135.126.0.223
																135.126.0.255
																135.126.1.31
																135.126.1.63
																135.126.1.95
																135.126.1.127
																135.126.1.159
																135.126.1.191
																135.126.1.223
																135.126.1.255

Practical Subnetting 3

Based on the information in the graphic shown, design a classfull network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 25% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Address class	<u>B</u>
Custom subnet mask	<u>255.255.255.0</u>
Minimum number of subnets needed	<u>4</u>
Extra subnets required for 25% growth (Round up to the next whole number)	<u>+ 1</u>
Total number of subnets needed	<u>= 5</u>
Number of host addresses in the largest subnet group	<u>185</u>
Number of addresses needed for 25% growth in the largest subnet (Round up to the next whole number)	<u>+ 47</u>
Total number of address needed for the largest subnet	<u>= 232</u>

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Sales	<u>172.16.0.0 to 172.16.0.255</u>
IP address range for Marketing	<u>172.16.1.0 to 172.16.1.255</u>
IP address range for Administrative	<u>172.16.2.0 to 172.16.2.255</u>
IP address range for Router A to Router B serial connection	<u>172.16.3.0 to 172.16.3.255</u>

Show your work for Problem 3 in the space below.

Number of Hosts

Number of Subnets

Binary values -

65,536

32,768

16,384

8,192

4,096

2,048

1,024

512

2

4

8

16

32

64

128

256

128

64

32

16

8

4

2

1

172.16.0.0

0

0

0

0

0

0

0

4

x.25

1

225

x.25

56.25

(Round up to 57)

(1)

(2)

(3)

(4)

(5)

(6)

(7)

(8)

(9)

(10)

(11)

(12)

(13)

(14)

(15)

(16)

0

1

1

1

0

0

1

1

0

0

0

1

0

1

0

1

172.16.0.0

to

172.16.0.255

172.16.1.0

to

172.16.1.255

172.16.2.0

to

172.16.2.255

172.16.3.0

to

172.16.3.255

172.16.4.0

to

172.16.4.255

172.16.5.0

to

172.16.5.255

172.16.6.0

to

172.16.6.255

172.16.7.0

to

172.16.7.255

172.16.8.0

to

172.16.8.255

172.16.9.0

to

172.16.9.255

172.16.10.0

to

172.16.10.255

172.16.11.0

to

172.16.11.255

172.16.12.0

to

172.16.12.255

172.16.13.0

to

172.16.13.255

172.16.14.0

to

172.16.14.255

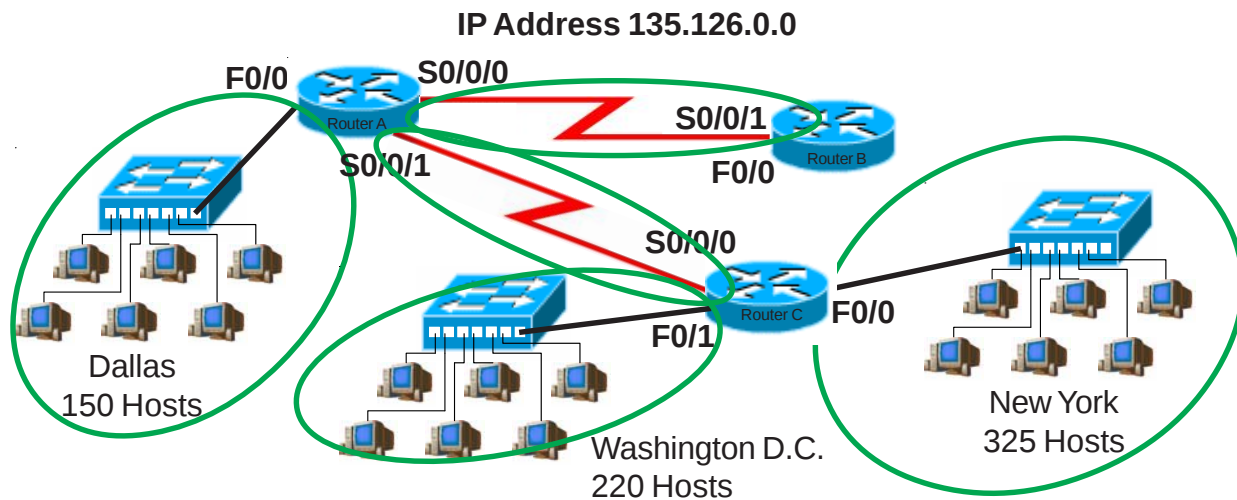
172.16.15.0

to

172.16.15.255

Practical Subnetting 4

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of subnets**, and allow enough extra subnets and hosts for 70% growth in all areas. Circle each subnet on the graphic and answer the questions below. Circle each subnet on the graphic and answer the questions below.



Address class	B
Custom subnet mask	255.255.240.0
Minimum number of subnets needed	5
Extra subnets required for 70% growth (Round up to the next whole number)	+ 4
Total number of subnets needed	= 9
Number of host addresses in the largest subnet group	325
Number of addresses needed for 70% growth in the largest subnet (Round up to the next whole number)	+ 228
Total number of address needed for the largest subnet	= 553

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for New York	<u>135.126.0.0 to 135.126.15.255</u>
IP address range for Washington D. C.	<u>135.126.16.0 to 135.126.31.255</u>
IP address range for Dallas	<u>135.126.32.0 to 135.126.47.255</u>
IP address range for Router A to Router B serial connection	<u>135.126.48.0 to 135.126.63.255</u>
IP address range for Router A to Router C serial connection	<u>135.126.64.0 to 135.126.79.255</u>

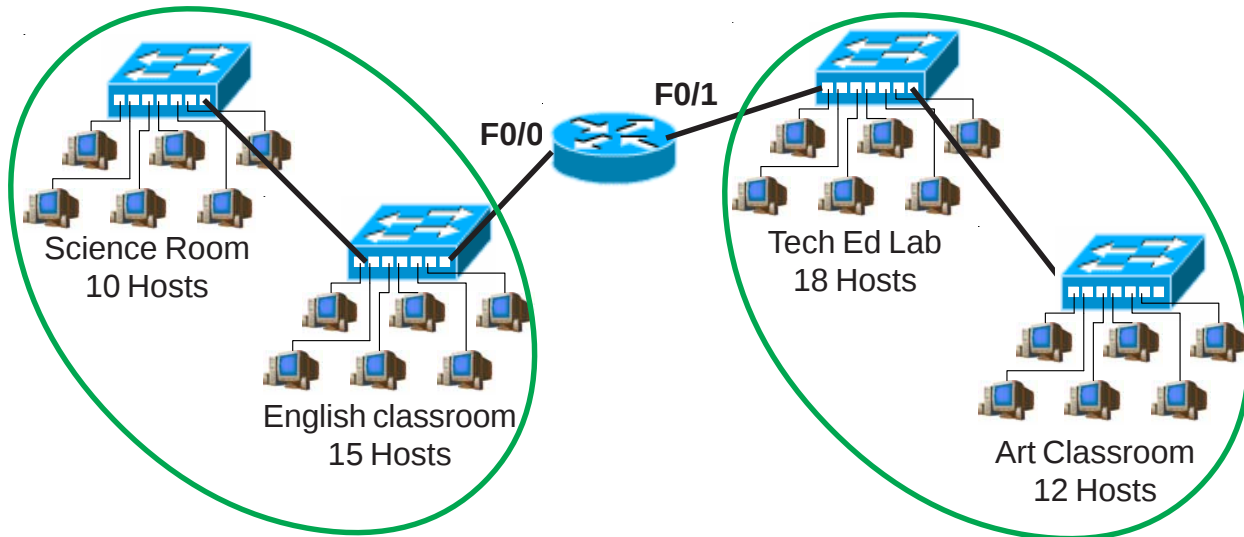
Show your work for Problem 4 in the space below.

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets -	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Binary values -	128	64	32	16	8	4	2	1	.	.	.	.	.	.	.	.
135.126.0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
(2)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3)	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
(4)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(6)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(7)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(8)	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
(9)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(10)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(11)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(12)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(13)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(14)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(15)	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
(16)	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
135.126.0.0	135.126.0.0	135.126.16.0	135.126.32.0	135.126.48.0	135.126.64.0	135.126.80.0	135.126.96.0	135.126.112.0	135.126.128.0	135.126.144.0	135.126.160.0	135.126.176.0	135.126.192.0	135.126.208.0	135.126.224.0	135.126.240.0
to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to
135.126.15.255	135.126.31.255	135.126.47.255	135.126.63.255	135.126.79.255	135.126.95.255	135.126.111.255	135.126.127.255	135.126.143.255	135.126.159.255	135.126.175.255	135.126.191.255	135.126.207.255	135.126.223.255	135.126.239.255	135.126.255.255	135.126.255.255

Practical Subnetting 5

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 100% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 210.15.10.0



Address class	<u>C</u>
Custom subnet mask	<u>255.255.255.192</u>
Minimum number of subnets needed	<u>2</u>
Extra subnets required for 100% growth (Round up to the next whole number)	<u>+ 2</u>
Total number of subnets needed	<u>= 4</u>
Number of host addresses in the largest subnet group	<u>30</u>
Number of addresses needed for 100% growth in the largest subnet (Round up to the next whole number)	<u>+ 30</u>
Total number of address needed for the largest subnet	<u>= 60</u>

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Router F0/0 Port 210.15.10.0 to 210.15.10.63

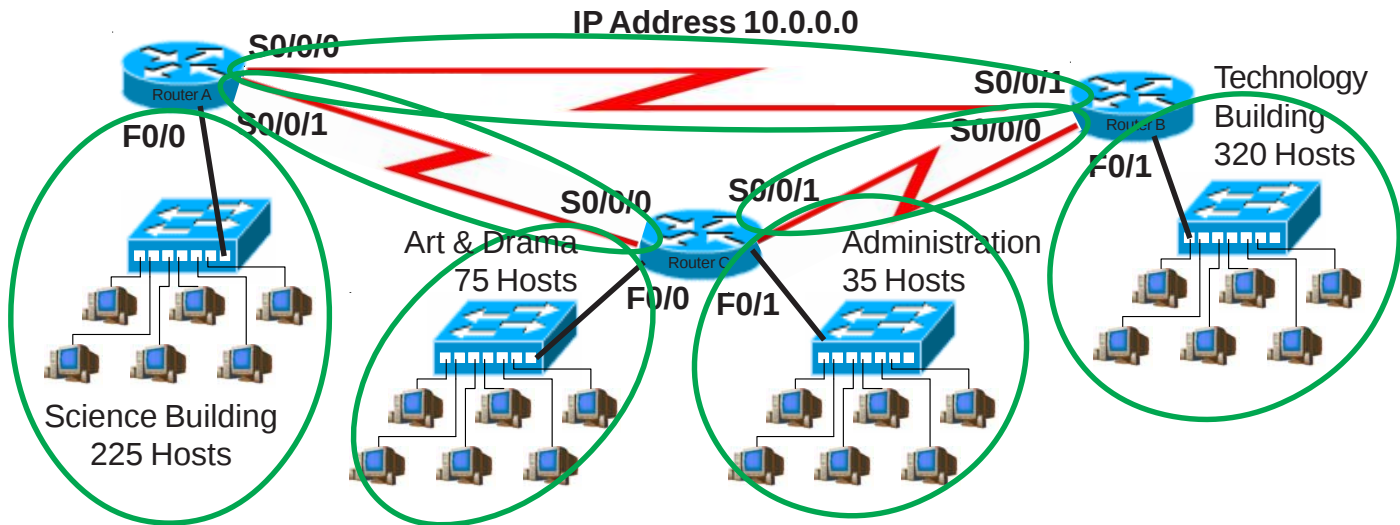
IP address range for Router F0/1 Port 210.15.10.64 to 210.15.10.127

Show your work for Problem 5 in the space below.

		256	128	64	32	16	8	4	2	-	Number of Hosts
Number of Subnets		-	2	4	8	16	32	64	128	256	
		128	64	32	16	8	4	2	1	-	Binary values
210. 15 . 10 . 0 0 0 0 0 0 0 0											
(1)	0	210.15.10.0				to		210.15.10.63			
(2)	1	210.15.10.64				to		210.15.10.127			
(3)	1 0	210.15.10.128				to		210.15.10.191			
(4)	1 1	210.15.10.192				to		210.15.10.255			

Practical Subnetting 6

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of subnets**, and allow enough extra subnets and hosts for 20% growth in all areas. Circle each subnet on the graphic and answer the questions below. Circle each subnet on the graphic and answer the questions below.



Address class	<u>A</u>
Custom subnet mask	<u>255.240.0.0</u>
Minimum number of subnets needed	<u>7</u>
Extra subnets required for 20% growth (Round up to the next whole number)	<u>+ 2</u>
Total number of subnets needed	<u>= 9</u>

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

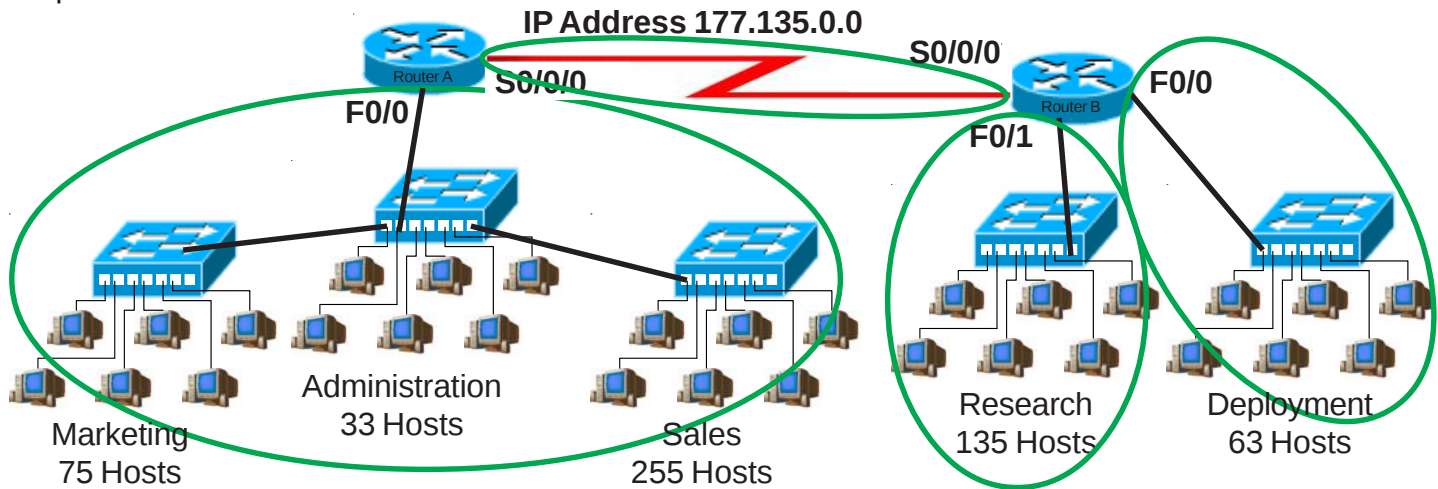
IP address range for Technology	<u>10.0.0.0 to 10.15.255.255</u>
IP address range for Science	<u>10.16.0.0 to 10.31.255.255</u>
IP address range for Arts & Drama	<u>10.32.0.0 to 10.47.255.255</u>
IP Address range Administration	<u>10.48.0.0 to 10.63.255.255</u>
IP address range for Router A to Router B serial connection	<u>10.64.0.0 to 10.79.255.255</u>
IP address range for Router A to Router C serial connection	<u>10.80.0.0 to 10.95.255.255</u>
IP address range for Router B to Router C serial connection	<u>10.96.0.0 to 10.111.255.255</u>

Show your work for Problem 6 in the space below.

[illegible]

Practical Subnetting 7

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 125% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Address class	<u>B</u>
Custom subnet mask	<u>255.255.252.0</u>
Minimum number of subnets needed	<u>4</u>
Extra subnets required for 125% growth (Round up to the next whole number)	<u>+ 5</u>
Total number of subnets needed	<u>= 9</u>
Number of host addresses in the largest subnet group	<u>363</u>
Number of addresses needed for 125% growth in the largest subnet (Round up to the next whole number)	<u>+ 454</u>
Total number of address needed for the largest subnet	<u>= 817</u>

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

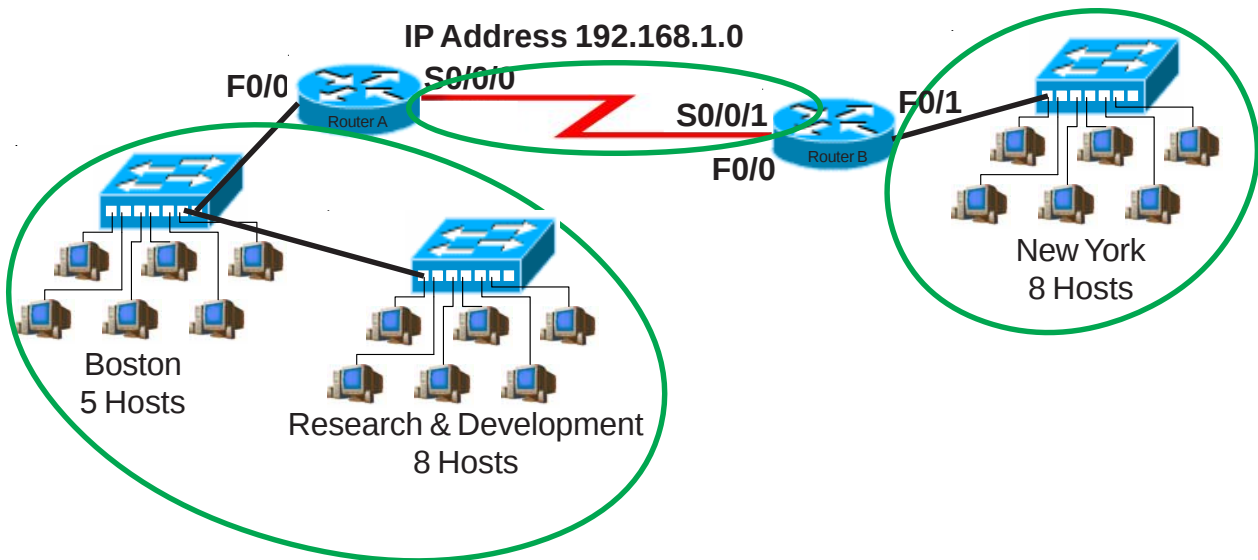
IP address range for Router A Port F0/0	<u>177.135.0.0 to 177.135.3.255</u>
IP address range for Research	<u>177.135.4.0 to 177.135.7.255</u>
IP address range for Deployment	<u>177.135.8.0 to 177.135.11.255</u>
IP address range for Router A to Router B serial connection	<u>177.135.12.0 to 177.135.15.255</u>

Show your work for Problem 7 in the space below.

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets -	2	4	8	16	32	64	128	256								
Binary values -	128	64	32	16	8	4	2	1								
177.135 .	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.								177.135.0.0	to	177.135.3.255					
(2)									177.135.4.0	to	177.135.7.255					
(3)									177.135.8.0	to	177.135.11.255					
(4)									177.135.12.0	to	177.135.15.255					
(5)									177.135.16.0	to	177.135.19.255					
(6)									177.135.20.0	to	177.135.23.255					
(7)									177.135.24.0	to	177.135.27.255					
(8)									177.135.28.0	to	177.135.31.255					
(9)									177.135.32.0	to	177.135.35.255					
(10)									177.135.36.0	to	177.135.39.255					
(11)									177.135.40.0	to	177.135.43.255					
(12)									177.135.44.0	to	177.135.47.255					
(13)									177.135.48.0	to	177.135.51.255					
(14)									177.135.52.0	to	177.135.55.255					
(15)									177.135.56.0	to	177.135.59.255					
(16)									177.135.60.0	to	177.135.63.255					

Practical Subnetting 8

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number subnets**, and allow enough extra subnets and hosts for 85% growth in all areas. Circle each subnet on the graphic and answer the questions below. Circle each subnet on the graphic and answer the questions below.



Address class

C

Custom subnet mask

255.255.255.224

Minimum number of subnets needed

3

Extra subnets required for 85% growth
(Round up to the next whole number)

+ 3

Total number of subnets needed

= 6

Number of host addresses
in the largest subnet group

13

Number of addresses needed for
85% growth in the largest subnet
(Round up to the next whole number)

+ 12

Total number of address
needed for the largest subnet

= 25

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Router A F0/0

192.168.1.0 to 192.168.1.31

IP address range for New York

192.168.1.32 to 192.168.1.63

IP address range for Router A
to Router B serial connection

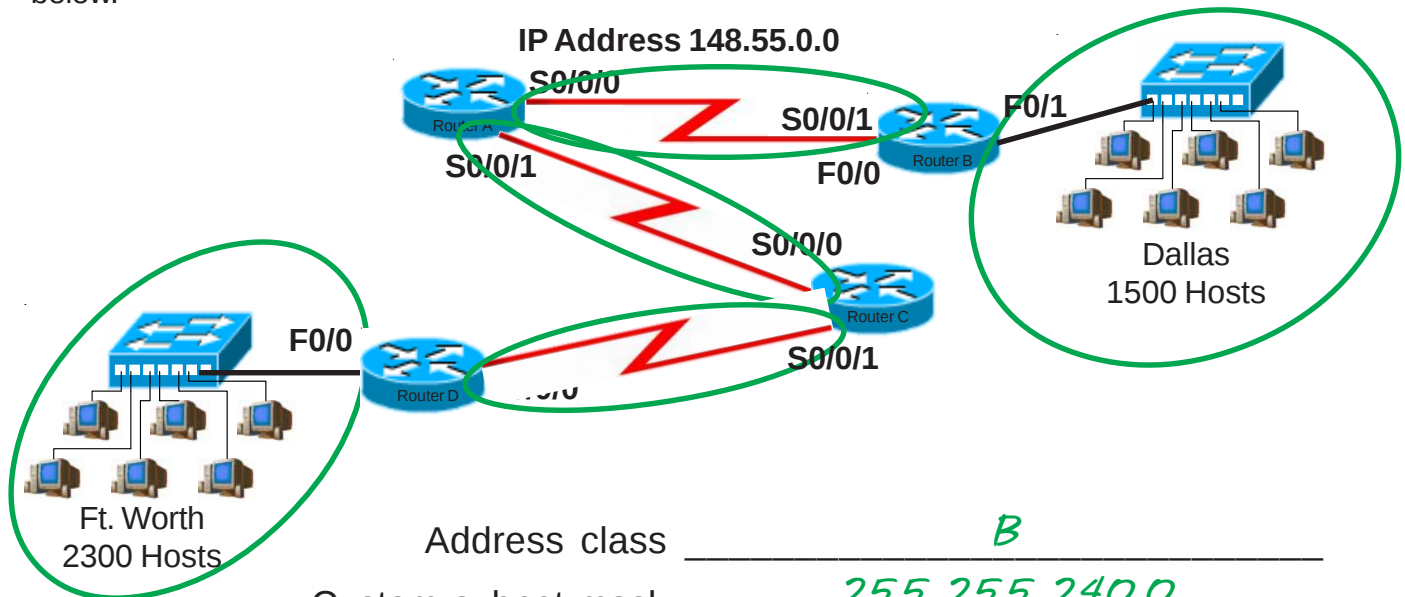
192.168.1.64 to 192.168.1.95

Show your work for Problem 8 in the space below.

Number of Subnets	256	128	64	32	16	8	4	2	-	Number of Hosts
	2	4	8	16	32	64	128	256		
	128	64	32	16	8	4	2	1	-	Binary values
192.168.1.0 0 0 0 0 0										
(1)			0	192.168.1.0				to	192.168.1.31	
(2)			1	192.168.1.32				to	192.168.1.63	
(3)		1	0	192.168.1.64				to	192.168.1.95	
(4)		1	1	192.168.1.96				to	192.168.1.127	
(5)	1	0	0	192.168.1.128				to	192.168.1.159	
(6)	1	0	1	192.168.1.160				to	192.168.1.191	
(7)	1	1	0	192.168.1.192				to	192.168.1.223	
(8)	1	1	1	192.168.1.224				to	192.168.1.255	

Practical Subnetting 9

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 15% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Address class	<u>B</u>
Custom subnet mask	<u>255.255.240.0</u>
Minimum number of subnets needed	<u>5</u>
Extra subnets required for 15% growth (Round up to the next whole number)	<u>+ 1</u>
Total number of subnets needed	<u>= 6</u>
Number of host addresses in the largest subnet group	<u>2300</u>
Number of addresses needed for 15% growth in the largest subnet (Round up to the next whole number)	<u>+ 345</u>
Total number of address needed for the largest subnet	<u>= 2645</u>

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

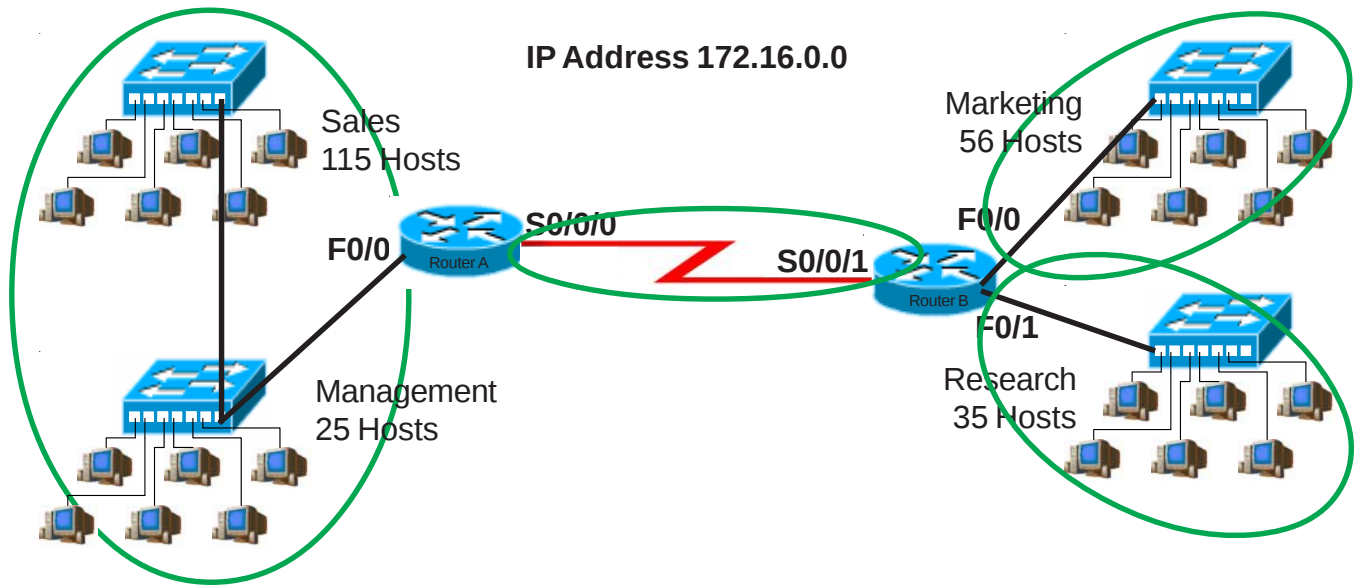
IP address range for Ft. Worth	<u>148.55.0.0 to 148.55.15.255</u>
IP address range for Dallas	<u>148.55.16.0 to 148.55.31.255</u>
IP address range for Router A to Router B serial connection	<u>148.55.32.0 to 148.55.47.255</u>
IP address range for Router A to Router C serial connection	<u>148.55.48.0 to 148.55.63.255</u>
IP address range for Router C to Router D serial connection	<u>148.55.64.0 to 148.55.79.255</u>

Show your work for Problem 9 in the space below.

Number of Hosts -	256	128	64	32	16	8	4	2
65,536								
32,768								
16,384								
8,192								
4,096								
2,048								
1,024								
512								
256								
128								
64								
32								
16								
8								
4								
2								
1								
0								
148.55.0.0								
148.55.15.255								
148.55.31.255								
148.55.47.255								
148.55.63.255								
148.55.79.255								
148.55.95.255								
148.55.111.255								
148.55.127.255								
148.55.143.255								
148.55.159.255								
148.55.175.255								
148.55.191.255								
148.55.207.255								
148.55.223.255								
148.55.239.255								
148.55.255.255								

Practical Subnetting 10

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of subnets**, and allow enough extra subnets and hosts for 110% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Address class	<u>B</u>
Custom subnet mask	<u>255.255.255.240</u>
Minimum number of subnets needed	<u>4</u>
Extra subnets required for 110% growth (Round up to the next whole number)	<u>+ 5</u>
Total number of subnets needed	<u>= 9</u>
Number of host addresses in the largest subnet group	<u>140</u>
Number of addresses needed for 110% growth in the largest subnet (Round up to the next whole number)	<u>+ 154</u>
Total number of address needed for the largest subnet	<u>= 294</u>

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Sales/Management	<u>172.16.0.0 to 172.16.15.255</u>
IP address range for Marketing	<u>172.16.16.0 to 172.16.31.255</u>
IP address range for Research	<u>172.16.32.0 to 172.16.47.255</u>
IP address range for Router A to Router B serial connection	<u>172.16.48.0 to 172.16.63.255</u>

Show your work for Problem 10 in the space below.

Number of Hosts -	8,192	16,384	32,768	65,536	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Number of Subnets -	16	8	4	2	1	1	2	4	8	16	32	64	128
Binary values -	128	64	32	16	8	4	2	1	256	512	1,024	2,048	4,096
	172.16.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0
(1)	0								172.16.0.0	to	172.16.15.255		
(2)	1								172.16.16.0	to	172.16.31.255		
(3)		1							172.16.32.0	to	172.16.47.255		
(4)		1	1						172.16.48.0	to	172.16.63.255		
(5)		1	0	0					172.16.64.0	to	172.16.79.255		
(6)		1	0	1					172.16.80.0	to	172.16.95.255		
(7)		1	1	0					172.16.96.0	to	172.16.111.255		
(8)		1	1	1					172.16.112.0	to	172.16.127.255		
(9)	1	0	0	0					172.16.128.0	to	172.16.143.255		
(10)	1	0	0	1					172.16.144.0	to	172.16.159.255		
(11)	1	0	1	0					172.16.160.0	to	172.16.175.255		
(12)	1	0	1	1					172.16.176.0	to	172.16.191.255		
(13)	1	1	0	0					172.16.192.0	to	172.16.207.255		
(14)	1	1	1	0					172.16.208.0	to	172.16.223.255		
(15)	1	1	1	1					172.16.224.0	to	172.16.239.255		
(16)	1	1	1	1					172.16.240.0	to	172.16.255.255		

Valid and Non-Valid IP Addresses

Using the material in this workbook identify which of the addresses below are correct and usable. If they are not usable addresses explain why.

IP Address: 0.230.190.192

Subnet Mask: 255.0.0.0

Reference Page Inside Front Cover

The network ID cannot be 0.

IP Address: 192.10.10.1

Subnet Mask: 255.255.255.0

Reference Pages 28-29

OK

IP Address: 245.150.190.10

Subnet Mask: 255.255.255.0

Reference Page Inside Front Cover

245 is reserved for experimental use.

IP Address: 135.70.191.255

Subnet Mask: 255.255.254.0

Reference Pages 48-49

This is the broadcast address for this range.

IP Address: 127.100.100.10

Subnet Mask: 255.0.0.0

Reference Pages Inside Front Cover

127 is reserved for loopback testing.

IP Address: 93.0.128.1

Subnet Mask: 255.255.224.0

Reference Pages 56-57

OK

IP Address: 200.10.10.128

Subnet Mask: 255.255.255.224

Reference Pages 54-55

This is the subnet address for the 3rd usable range of 200.10.10.0

IP Address: 165.100.255.189

Subnet Mask: 255.255.255.192

Reference Pages 30-31

OK

IP Address: 190.35.0.10

Subnet Mask: 255.255.255.192

Reference Pages 34-35

This address is taken from the first range for this subnet which is invalid.

IP Address: 218.35.50.195

Subnet Mask: 255.255.0.0

Reference Page Inside Front Cover

This has a class B subnet mask.

IP Address: 200.10.10.175 /22

Reference Pages 54-55 and/or Inside Front Cover

A class C address must use a minimum of 24 bits.

IP Address: 135.70.255.255

Subnet Mask: 255.255.224.0

Reference Pages 48-49

This is a broadcast address.

IP Address Breakdown

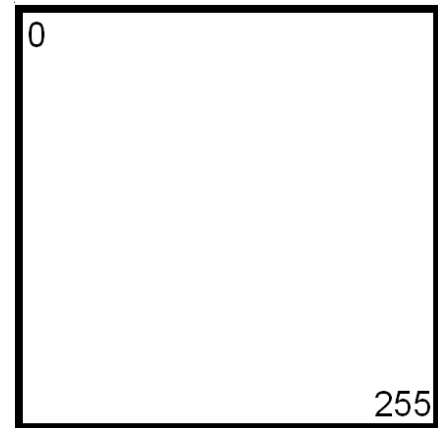
/24	/25	/26	/27	/28	/29	/30
8+8+8	8+8+8+1	8+8+8+2	8+8+8+3	8+8+8+4	8+8+8+5	8+8+8+6
255.255.255.0	255.255.255.128	255.255.255.192	255.255.255.224	255.255.255.240	255.255.255.248	255.255.255.252
256 Hosts	128 Hosts	64 Hosts	32 Hosts	16 Hosts	8 Hosts	4 Hosts
0-255	0-127	0-63		0-15	0-7	0-3
					4-7	
				8-15	8-11	
					12-15	
			16-31	16-19		
				20-23		
				24-27		
				28-31		
		32-47	32-35			
			36-39			
			40-43			
			44-47			
			48-63	48-51		
				52-55		
				56-59		
				60-63		
		64-127	64-67			
			68-71			
			72-75			
			76-79			
	80-83					
	84-87					
	88-91					
	92-95					
	96-99					
	100-103					
	104-107					
	108-111					
	112-127	112-115				
		116-119				
		120-123				
		124-127				
	128-255	128-191		128-143	128-135	128-131
					132-135	
				136-143	136-139	
				140-143		
			144-159	144-147		
				148-151		
				152-155		
				156-159		
160-175			160-163			
			164-167			
			168-171			
			172-175			
176-191		176-179				
		180-183				
		184-187				
		188-191				
192-255			192-207	192-199	192-195	
				196-199		
				200-203		
				204-207		
			208-223	208-211		
				212-215		
				216-219		
				220-223		
		224-239	224-227			
			228-231			
			232-235			
			236-239			
	240-243					
	244-247					
	248-251					
	252-255					

Visualizing Subnets Using The Box Method

The box method is the simplest way to visualize the breakdown of subnets and addresses into smaller sizes.

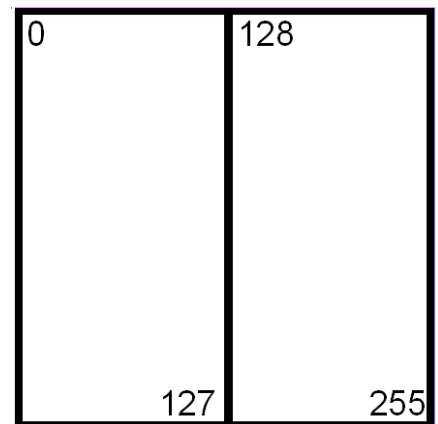
Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24
255.255.255.0
256 Hosts
1 Subnet



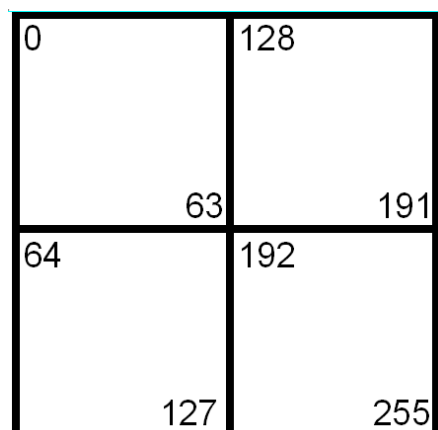
Split the box in half and you get two subnets with 128 addresses,

/25
255.255.255.128
128 Hosts
2 Subnets



Divide the box into quarters and you get four subnets with 64 addresses,

/26
255.255.255.192
64 Hosts
4 Subnets



Split each individual square and you get eight subnets with 32 addresses,

/27
255.255.255.224
32 Hosts
8 Subnets

0	32	128	160
31	63	159	191
64	96	192	224
95	127	223	255

Split the boxes in half again and you get sixteen subnets with sixteen addresses,

/28
255.255.255.240
16 Hosts
16 Subnets

0	32	128	160
15	47	143	175
16	48	144	176
31	63	159	191
64	96	192	224
79	111	207	239
80	112	208	240
95	127	223	255

The next split gives you thirty two subnets with eight addresses,

/29
255.255.255.248
8 Hosts
32 Subnets

0	8	32	40	128	136	160	168
7	15	39	47	135	143	167	175
16	24	48	56	144	152	176	184
23	31	55	63	151	159	183	191
64	72	96	104	192	200	224	232
71	79	103	111	199	207	321	239
80	88	112	120	208	216	240	248
87	95	119	127	215	223	247	255

The last split gives sixty four subnets with four addresses each,

/30
255.255.255.252
4 Hosts
64 Subnets

0	8	32	40	128	136	160	168
3	11	35	43	131	139	163	171
4	12	36	44	132	140	164	172
7	15	39	47	135	143	167	175
16	24	48	56	144	152	176	184
19	27	51	59	147	155	179	187
20	28	52	60	148	156	180	188
23	31	55	63	151	159	183	191
64	72	96	104	192	200	224	232
67	75	99	107	195	203	227	235
68	76	100	108	196	204	228	236
71	79	103	111	199	207	321	239
80	88	112	120	208	216	240	248
83	91	115	123	211	219	243	251
84	92	116	124	212	220	244	252
87	95	119	127	215	223	247	255

Class A Addressing Guide

CIDR	# of Bits Borrowed	Subnet Mask	Total # of Subnets	Total # of Hosts	Usable # of Hosts
/8	0	255.0.0.0	1	16,777,216	16,777,214
/9	1	255.128.0.0	2	8,388,608	8,388,606
/10	2	255.192.0.0	4	4,194,304	4,194,302
/11	3	255.224.0.0	8	2,097,152	2,097,150
/12	4	255.240.0.0	16	1,048,576	1,048,574
/13	5	255.248.0.0	32	524,288	524,286
/14	6	255.252.0.0	64	262,144	262,142
/15	7	255.254.0.0	128	131,072	131,070
/16	8	255.255.0.0	256	65,536	65,534
/17	9	255.255.128.0	512	32,768	32,766
/18	10	255.255.192.0	1,024	16,384	16,382
/19	11	255.255.224.0	2,048	8,192	8,190
/20	12	255.255.240.0	4,096	4,096	4,094
/21	13	255.255.248.0	8,192	2,048	2,046
/22	14	255.255.252.0	16,384	1,024	1,022
/23	15	255.255.254.0	32,768	512	510
/24	16	255.255.255.0	65,536	256	254
/25	17	255.255.255.128	131,072	128	126
/26	18	255.255.255.192	262,144	64	62
/27	19	255.255.255.224	524,288	32	30
/28	20	255.255.255.240	1,048,576	16	14
/29	21	255.255.255.248	2,097,152	8	6
/30	22	255.255.255.252	4,194,304	4	2

Class B Addressing Guide

CIDR	# of Bits Borrowed	Subnet Mask	Total # of Subnets	Total # of Hosts	Usable # of Hosts
/16	0	255.255.0.0	1	65,536	65,534
/17	1	255.255.128.0	2	32,768	32,766
/18	2	255.255.192.0	4	16,384	16,382
/19	3	255.255.224.0	8	8,192	8,190
/20	4	255.255.240.0	16	4,096	4,094
/21	5	255.255.248.0	32	2,048	2,046
/22	6	255.255.252.0	64	1,024	1,022
/23	7	255.255.254.0	128	512	510
/24	8	255.255.255.0	256	256	254
/25	9	255.255.255.128	512	128	126
/26	10	255.255.255.192	1,024	64	62
/27	11	255.255.255.224	2,048	32	30
/28	12	255.255.255.240	4,096	16	14
/29	13	255.255.255.248	8,192	8	6
/30	14	255.255.255.252	16,384	4	2

Class C Addressing Guide

CIDR	# of Bits Borrowed	Subnet Mask	Total # of Subnets	Total # of Hosts	Usable # of Hosts
/24	0	255.255.255.0	1	256	254
/25	1	255.255.255.128	2	128	126
/26	2	255.255.255.192	4	64	62
/27	3	255.255.255.224	8	32	30
/28	4	255.255.255.240	16	16	14
/29	5	255.255.255.248	32	8	6
/30	6	255.255.255.252	64	4	2

